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Unification of Industrial Effort

It is well known that at the moment there is in existence a divergence of opinion amongst ironfounders as to what are the best steps to take in order to organise an employers' association within the industry in such a manner that it will be most effective. There are now three bodies of major importance which voice the opinions of ironfounders in national affairs. The British Ironfounders' Association is particularly well placed to speak for that important group of ironfounders manufacturing builders' castings. Then there is the National Ironfounding Employers' Federation, which functions through a committee made up of delegates chosen by the district foundry employers' associations, and finally there is the more recently created Ironfounders' National Confederation. This last concern came into existence with the specific object of providing a mouthpiece capable of voicing the interests of the whole of the foundry industry in national affairs. It was believed, and there were good grounds for the assumption, that the existing organisations were insufficiently complete to ensure adequate national representation. Many of the attached foundries were not affiliated, nor were all those operated by the pig-iron producers and railway companies. Moreover, there were some outstandingly large foundries which the district associations had been unable to enrol. Furthermore, there were foundries, which, due to geographical isolation saw no good reason for membership. It is becoming more and more obvious, that whilst there may be room—assuming that proper co-operation be established—for two associations, yet public opinion is dead against three. The one which must continue is the British Ironfounders' Association, as it represents very adequately one important section of the industry, and is brilliantly organised. Of the other two there is an overlapping of interests, and ironfounders are rightly insisting that they should not be called upon to join two bodies having analogous functions. Negotiations of an important character are now proceeding, and their outcome should be such that all foundry employers will be in a position to take a clear-cut decision as to future action. When this time arrives, we counsel them to put aside all past prejudices, and work for an overriding association which will afford every firm dual representation. By this we mean, that existing district committees must be strengthened and new ones created where none exists, and groups of firms making similar lines should likewise have their associations reinforced, or that new groups should be formed where no body looks after their interests. This dual aspect of interests can only be taken care of properly by a national body having 100 per cent. membership, plus the necessary funds which such an organisation requires. It is obvious that, for some foundries, the district organisation makes a greater appeal than one handling the affairs of foundries making similar lines of goods, whilst the reverse is true in many other cases. We are confident that, if goodwill is shown on all sides, a truly representative body will come into existence. Presuming that after a period, this parent body possesses funds, then the utmost discrimination must be exercised in their disposal. There is an *ab initio* realisation that the interests of the foundry industry are wide and varied. Thus it is clear that expenditure on matters affecting the whole industry, such as representation at railway rates tribunals; negotiations with Government Departments and the like is best left to the parent body, but grants for research and education should be effected through the trade groups or regional committees, otherwise established interests will be jeopardised and jealousies aroused. If the industry will bear these points in mind when they come to make their decisions in the near future, the outcome of their deliberations will assure the best possible representation of their trade interests.

Nickel in Agricultural Implement Castings

The last issue of the "Nickel Bulletin" contains a lengthy abstract of an article by Mr. H. Geiger on "The Rôle of Nickel in the Production of Farm Tools," which appeared originally in "Agricultural Engineering," an American journal. Most of the article deals with the steels employed, their hardening and nickel plating. The portion dealing with the components made in cast iron is set out below.

In the agricultural implement field there are numerous parts which, from the combined standpoint of cost and properties, are best made from cast iron. Many of the qualities required in such components are very appreciably enhanced by the use of an alloy iron, as will be readily evident from the following list of the effects of nickel: (1) It raises the tensile strength; (2) eliminates chill; (3) raises cast hardness; (4) improves machinability at higher hardnesses; (5) increases wear-resistance; (6) improves response to heat-treatment; (7) offsets chilling effect of chill-forming alloys; (8) lowers notch-sensitivity; (9) increases resistance to fatigue; (10) refines grain and graphite particle size; (11) contributes to vibration-damping properties, and (12) raises modules of elasticity. These effects of nickel are individually discussed in the present Paper, as affecting the design and operation of agricultural equipment. The use of nickel as a chill-eliminator is given special prominence, in view of the fact that it so vitally affects the machining qualities of cast irons used in agricultural implement production.

A further feature of importance in agricultural applications, *e.g.*, gears, is the hardness and wear-resistance of the irons. (A curve illustrating the influence of alloying on wear-resistance is given in the original Paper.)

Compositions found suitable for gears and sprockets are shown in the original. The carbon content of the irons ranges from 2.8 to 3.2 per cent., with silicon 1.5 to 2.0, nickel up to 1.75, per cent., and small percentages of chromium and/or molybdenum.

Crankshafts

A further satisfactory application of alloy iron is for single-throw crankshafts of the type used for one-cylinder air-cooled engines of small tractors and individual small farm lighting units, crankshafts for corn shellers, Diesel engine starting cranks, etc. For this purpose high strengths are necessary, while increased resistance to wear on the bearing surfaces, reduced tendency to seizing, and higher torsional strengths are additional assets. The increase in rigidity which, in cast iron, accompanies rise in tensile strength, is also an advantage in crankshaft irons. The nickel-molybdenum irons are especially favoured for this application, due to their combined toughness and strength. Mechanical properties of typical crankshaft irons are tabulated and reference is made to the damping capacity of cast iron, which is a further factor of importance in ensuring smooth operation.

Motor castings for tractor water-cooled cylinder blocks and heads, air-cooled cylinder heads for single-cylinder motors used in hand garden tractors, cylinder lines both wet and dry, and pistons, generally contain nickel in various amounts, in order to increase density and strength, to raise the overall hardness and provide increased wear, to minimise warpage, and to render the castings readily machinable. Typical compositions, suitable for engines of varying size, are shown in the original article.

Replaceable Liners

Replaceable liners have for some time been used, in the heat-treated condition, in tractor motors, where the optimum in wear-resistance is needed. The alloying elements present influence the reaction of the iron to heat-treatment in much the same way as when present in steel, and tests on the hardening characteristics of irons containing various alloy combinations have led to the selection, for wear-resisting liners, of irons containing nickel 1 to 2, chromium 0.25 to 0.75, per cent., the exact composition depending on the degree of stability and hardness required at motor-operating temperatures. For specially high properties, a nickel-molybdenum or nickel-chromium-molybdenum iron may be used.

Valve inserts, which require resistance to pounding by the valves and to deterioration at raised temperature, are also currently made from alloy iron. Nickel 0.5 to 1.5, chromium 0.3 to 0.7, molybdenum 0.3 to 0.5 per cent., is the range generally favoured for this purpose. Pulleys and clutch plates are further examples of the uses of the lower nickel alloy irons in agricultural equipment.

For implement parts in which specially high hardness and abrasion-resistance are essential, the use of "Ni-Hard" (martensitic cast iron containing about 4.5 per cent. nickel and 1.5 per cent. chromium) has proved extremely successful. Typical applications include grinding burrs and plough points.

Factory Lighting Regulations

A further step towards increased production has been taken by the Government with the recent legislation in respect to the lighting of factories. Many of the recommendations of the Fifth Report of the Departmental Committee on Lighting in Factories have been embodied in the Regulations which were signed on January 14 and became mandatory on February 1, 1941.

The Factories (Standards of Lighting) Regulations apply to factories in which persons are being regularly employed for more than 48 hours per week, or in shifts, with certain exceptions. Briefly, the Regulations with which factories have to comply are:—

1.—The general illumination over those interior parts of the factory where persons are regularly employed shall be not less than 6 foot-candles measured in the horizontal plane at a level of 3 ft. above the floor.

2.—The illumination over all other parts of the factory over which persons employed pass shall, when and where a person is passing, be not less than 0.5 foot-candles measured at floor level.

3.—The standards specified shall be without prejudice to the provision of any additional illumination required to render the lighting sufficient and suitable for the nature of the work.

4.—No glaring light source is permitted and local lights must either be provided with a suitable shade of opaque material to prevent glare or the light source completely screened from the eyes of every worker employed at a normal working place.

5.—Suitable arrangements shall be made to prevent discomfort or injury by the reflection of light from smooth or polished surfaces into the eyes of the worker, and as far as reasonably practicable, to prevent the formation of shadows which cause eyestrain or risk of accident.

Provision is made for the Chief Inspector of Factories to grant a certificate of exemption for factories or parts of factories if he is satisfied that any requirement of the Regulations is inappropriate or not reasonably practicable.

In anticipation of these Regulations, the electrical industry established the National Industrial Electric Lighting Service so as to mobilise the services of qualified lighting engineers throughout the country to assist those factory executives and others who have no regular lighting advisor. The secretariat is vested in the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.

THE ANNUAL GENERAL MEETING of the Manchester Association of Engineers will be held at the Engineers' Club, Manchester, on March 22 at 2.30 p.m. It will be followed by a Paper on "Planning and Organisation for Wartime Management" by Mr. F. C. Lawrence, M.C., B.Sc.Tech., A.M.I.E.E., F.C.W.A., and Mr. C. J. Wilding Cole, M.A. (Cantab).

Random Shots

Many regular visitors to the office of THE FOUNDRY TRADE JOURNAL at Wellington Street during the piping days of peace, will remember Mr. John Butler, that fair-haired youth, who during the fifteen years in which he sat on the other side of the editorial desk, grew up into a tall, quiet and efficient assistant. He has joined the Royal Navy, and though it may seem a far cry from a journalistic desk to a ship's deck, yet, at least, the character of his work will not change in one respect, for he has left one silent service to join the Senior Silent Service. His own feelings on the matter are best described in the following couplet which was found on his desk [and which was purloined all unknown to him with the usual journalistic cheek].

Farewell to No. 3

'Twixt Printer's Devil and the Deep Blue Sea
These past few weeks my state has been—
J.B.
Now Neptune beckons, ocean calls to me,
When next I write, I'll sign myself—
A.B.

* * *

An old superstition that iron ore, when exhausted, would grow again, like a vegetable, has been recalled by "Lucio" of "The Manchester Guardian." The theory being, of course, that it would turnip again and sprout afresh.

* * *

The Italian Commander-in-chief in the North African campaign is reported to have issued a new Order of the Day. It reads simply: "Let's Jijiga-off."

* * *

Mr. Roosevelt's recent speech following the conclusion of the Lease and Lend Bill will long be remembered for its determination and purposefulness, and above all for its direct and forceful rhetoric; but the danger of using rhetoric for mere effect is illustrated in the following story. A pompous old dignitary of the church was delivering a speech at a girls' school on the annual prize-giving day. The smallest pupils, having sat patiently through two previous speeches, were getting restive. It took the dear old bishop some minutes to get warmed up to his subject, and before he could finally get down to it, he asked of his audience, "And the question is: 'What shall I talk to you about to-day?'" A small voice from the front row piped up, "About a minute, Sir."

* * *

"And the bride looked a fair treat," said Mrs. Malaprop the other day. "She was wearing one of those violet-infested hats."

* * *

Naughty Boy!

The best crossword clue of the week comes from "The Daily Telegraph."

Clue: Would cane-bottom chairs in his room be appropriate!

Answer: Headmaster.

MARKSMAN.

Raw Materials Per Ton of Steel

According to American computations, one net ton (2,000 lbs.) of finished open-hearth steel sections requires more than 4 net tons of raw materials, made up of 3,337 lbs. of iron ore, 2,150 lbs. of coal for coke making, 795 lbs. of limestone, 173 lbs. of dolomite, 1,190 lbs. of scrap, 618 lbs. of iron-bearing slags and by-products, and 33 lbs. of miscellaneous materials, a total of 8,296 lbs.

Metallurgical Coke from Petroleum Coke

Metallurgical coke can be manufactured from powdered petroleum coke obtained by cracking paraffinic residues and mixing with siliceous material, and carbonising the mixture in a coke oven, states H. HENDLER in "Moniteur petrole roumainie." Full-scale blast-furnace trials showed that with petroleum coke containing 10 per cent. of ash, the resulting product is comparable to ordinary metallurgical coke.

Cupola-Melted Blackheart Malleable Castings*

SOME NECESSARY PRECAUTIONS

By V. N. WOOD

The production of sound cupola-melted blackheart castings is a series of processes which necessitates strict metallurgical control throughout, otherwise many difficulties will appear. Most of these have root at the melting operation, and prevail right through to any machining operations which may be necessary on the finished product. Although any Paper on this subject must necessarily introduce some metallurgical considerations, the author will endeavour to avoid any involved technicalities and present the Paper from as practical a viewpoint as possible.

Choice of Raw Materials and Metal Composition

During the present times, the choice of the correct raw materials constitutes a problem in itself, and the careful utilisation of substitutes is a matter which demands a great deal of attention from the metallurgist if he is to maintain the quality of the product at the standard possible in normal times and using standard materials.

The successful manufacture of blackheart malleable castings initially depends on producing a white iron within narrow limits of composition which are such that a rather small variation in any one of its vital constituents is likely to introduce difficulties by either giving an iron too grey in character to be of any use as malleable iron or conversely a completely white iron having a deficiency in such elements as silicon and carbon. These are necessary in certain amounts to promote satisfactory annealing treatment later in the process.

A typical composition for cupola-melted blackheart malleable iron is:—T.C, 3.1; Si, 0.7; Mn, 0.50; S, 0.15; and P, 0.10 per cent.

The cupola was considered some years ago as being unsuitable for melting iron for malleable castings. It is now recognised, however, that a regular supply of hot metal of the desired uniformity can be obtained from the cupola for this purpose, provided that attention be given to every detail of cupola operation.

In the first place, owing to the lack of latitude permissible in the chemical composition of the iron, it is important that the charges of raw materials which generally consist of hard white iron scrap, hematite pig, steel scrap, small percentages of annealed scrap and ferro-alloys such as speigel and ferro-silicon, should be carefully weighed in their correct proportion. One consideration at the present time may be the variation in the size of steel scrap. One consignment may consist of clean pieces of substantial dimensions, whilst others may be of small rusty variety. On no account should the type of steel vary from charge to charge, it being a far wiser plan to mix small and large together. This should assist in preventing excessive oxidation, as would be the case if all small steel was used. As small steel would tend to be selectively melted much quicker than the larger accompanying pieces of pig-iron and iron scrap, the foregoing suggestion should prevent different melting rates of the charges and consequent variations in the metal from tap to tap, especially if the well of the cupola is of small capacity. If a large mixing ladle or receiver is used, variation from this source may not be so prevalent.

Manganese steel should be strictly avoided and care should be taken in the handling of machinery steel, which is often of the alloy type and may contain considerable amounts of chromium. The presence of small amounts of chromium in standard malleable castings renders them useless for the subsequent annealing process. The chromium content of the metal when tapped should not exceed 0.05 per cent.

Special care is necessary to ensure that the coke bed is made up to the same height for each successive melt. Too high a bed will give a metal of too high a carbon content, and the fracture will tend to be grey, giving danger of primary graphite in the castings, which is a great source of mechanical weakness in the annealed product. On the other hand, a low bed will give rise to metal of low carbon content, which will generally be cold and sluggish in character. Even with the best of conditions, molten white iron for malleable castings has a short "life," due to relatively low silicon, carbon and phosphorus contents, and it is essential that it should be transported and poured into the moulds as quickly as possible. Moreover, too low a carbon content along with low silicon will give difficulty in the annealing process, as will be seen later.

Another important factor is to maintain as far as possible the same rate of oxidation throughout the duration of the run. For this purpose the volume of the blast should remain as constant as possible and variations in pressure avoided.

Metal Consistency Controlled by Analyses and Fracture

Although frequent chemical analysis of the metal at regular intervals is necessary, the results in general cannot be obtained quickly enough to make modifications in the charges to correct any sudden divergence of metal composition due to any unforeseen irregularity in cupola operation, which are sometimes bound to occur in the most carefully regulated practice, often due to circumstances beyond the control of the metallurgist on the spot. They do, however, give a good idea of the general condition of the iron, and to some extent the working condition of the cupola with respect to the bed, coke and metal charges.

As a quicker additional check by fracture, a rough, but reliable, indication of metal composition can be obtained by pouring test-bars, allowing them to cool to a somewhat dull red temperature, at which the structure will be stable, and finally quenching in water. The quenched bar is then broken and the fracture examined, the time which elapses between the pouring and examination of the bar being controlled to a previously determined standard. If the fracture is not as desired, a further test-bar should be poured, and, if this is still unsatisfactory, the metallurgist can then make a correction by adjustments to the amounts of ferro-alloys, blast pressure and volume, or the weight of the coke charge.

A test bar which shows a rather mottled fracture may be attributed to too high a silicon content—the excess of coke giving high carbon content, deficiency of air or irregularity of tapping. A bar which is excessively white and brittle may be due to too low silicon, insufficient coke, too much air, especially at high pressure, and again irregularity of tapping.

Another useful purpose of the fractured test bar is, that it indicates the type and size of casting which shall be poured with the metal which is being tapped at the time. It is well known that two castings of different average metal thicknesses will give totally different fractures when poured with metal of the same composition. If the test bar contains a considerable number of grey mottles it may be permissible to pour castings of thin section without fear of primary graphite in the castings, whilst the pouring of castings of heavier section should be avoided. Similarly if the test piece shows freedom from mottle it can be taken for granted that castings of reasonably heavy section can be poured with safety.

Dangers of Very White Iron

One great source of trouble in the production of malleable castings is that of shrinkage. This is a matter which can largely be left in the hands of a capable patternmaker. However, the metallurgist in charge of the melting process can assist somewhat in this direction by the avoidance of metal of exceptionally-low silicon content; also, excessive amounts of hard iron, as cracks in castings can be traced to this source. Again, the tendency of the metal to excessive shrinkage can be observed in the fracture of the test bars, and although it is not always the case depending to some extent on the pouring temperature of the metal, the magnitude of the shrink in the bar varies with the whiteness and composition of the metal.

Another danger of very white and sluggishly pouring metal is the formation of blowholes and inclusions of trapped slag—it being insufficiently fluid to allow for the escape of released gases either from cores or air drawn in through the gates in pouring. The product in the cast state is naturally very hard and brittle, and must be malleablised by subjecting to an annealing treatment, which should be carried out under the constant supervision of an experienced metallurgist.

Annealing Furnace and Loading of Product

An annealing furnace of the batch type consists of a firebrick chamber, the size of which depends on the quantity of castings to be annealed. The flues for taking away the products of combustion may be constructed in the floor of the furnace, the floor also consisting of firebrick. The walls and roof should be completely encased with a layer of light insulating brick. Burners for the fuel may be located in the roof or walls, the position depending upon the shape of the furnace and the type of fuel used. Annealing furnaces may be fired either with pulverised coal, gas, fuel oil or coal. Access to the inside of the furnace for loading and unloading purposes is made possible by a thick, well-fitting firebrick lined door.

The castings are placed in round, square or rectangular white iron cans or pots, which may be built into a tier three or four high. The pots, which are usually flanged at the top, may be built into a tier up to 6 or 7 feet in height, depending of course upon the height of the annealing furnace. Beneath the bottom pot a robust stool with good strong legs should be used. This serves two purposes, first, to facilitate the handling of a full tier of castings by allowing the prongs of the lifting gear on a petrol or electric truck to pass underneath, and secondly to enable the hot furnace atmosphere to circulate beneath the bottom pot of the tier. If the base of the bottom pot were resting on the floor of the furnace the temperature of this part of the pot would lag behind the rest. Different types of castings require different means of packing before annealing.

* A Paper presented to the East Anglian Section of the Institute of British Foundrymen, Mr. H. H. Shepherd presiding. The author is Chief Assistant Metallurgist, Crane Limited, Ipswich.

It is important that thin and intricate castings should be carefully packed in some inert material such as burnt sand in order to prevent warping. More robust product may be loaded into pots without packing material providing that sound pots and lids are used. It is also very important that the furnace atmosphere which at times may be of an oxidising nature, should not come into direct contact with the castings. To minimise this danger a liberal application of a strong wet luting mixture, which may consist of fine sand and intimately mixed clay, is well rubbed into the joints formed by the bottom of each pot on the projecting flange of the one directly underneath. A sound and well fitting lid should cover the top pot of the tier which in turn should be rendered absolutely airtight by means of an application of luting mixture.

During the firing of a furnace in the initial stages, the location of the zone of combustion is generally somewhat better than the remainder of the furnace, so judgment should be exercised in the distribution of the weight of product to be placed in the furnace. Tiers of pots containing heavy castings or small jobs with a large ratio of metal weight to air space should be placed in the parts of the furnace which are known to receive the most heat. This precaution of placing the most weight in the area of the furnace which receives the most heat tends to even out any temperature differences likely to occur, particularly during the initial stages of the firing. The tiers should be loaded into the furnace so that the air space between each is even and sufficiently large to allow ample circulation of the furnace atmosphere.

For the best results, a soft rolling flame must be maintained during the whole firing operation. This is produced by using the minimum amount of air required in excess of that necessary for complete combustion of the fuel. In addition it is essential to have as part of the air used, an adequate amount of draft through the furnace to allow flexibility of flame control. The control should be carefully exercised by suitable flue dampers, as too much draft is likely to cause a rather fierce flame which may result in hot spots or zones. During the whole annealing process the temperature must be strictly controlled by means of reliable temperature recorders.

Stages in the Annealing Cycle

Annealing of blackheart malleable iron consists of three essential stages.

(1) *Heating-up Period.*—A period in which to raise the furnace to a predetermined temperature, known as the "at heat" temperature, generally between 850 and 950 deg. C., the choice depending upon the desired class and quality of the product, and to a great extent upon the average composition of the metal. The temperature gradient must not be forced, but maintained at such a rate that the heating is uniform throughout the furnace. For instance, with too rapid heating, the outside portion of a tier of castings may be really hot, whilst the castings in the centre may be comparatively cold.

The rate of heating is, of course, controlled by the size and capacity of the furnace, and with large furnaces holding 40 tons or more of metal the time required may be in the region of 36 to 40 hrs. or more. The rate of heating then, to the "at heat" temperature, should be so gradual as to ensure thorough and uniform heat penetration of the mass of product in the furnace.

(2) *Soaking Period.*—The next stage is to maintain the furnace at the required temperature for a sufficiently long period to promote and complete first-stage graphitisation. This operation is the breaking up of the massive cementite or carbide of iron, which is the hardest structural chief constituent of white iron, into a softer material, known as pearlite, along with nodules of graphite commonly known as temper carbon. The length of time required for this purpose depends upon the control temperature. The higher the temperature, the quicker the reaction. At 850 deg. C. the period required for the conversion would be 60 to 70 hrs., whilst at 950 deg. C. the reaction may be complete in about 36 hrs.

A finer-grained metal is obtained by the use of lower temperatures, but the time factor involved is a great disadvantage in quantity production work. With metal of suitable analysis, reasonably fine-grained fractures can be obtained with higher annealing temperatures, though excessively high temperatures give poor, coarse-grained metal.

(3) *Cooling-Down Period.*—The third and final stage of the annealing process is the cooling-down period, during which second-stage graphitisation takes place. When the furnace has been maintained at the desired temperature for the required time, the fuel is shut off, any dampers closed, and all openings to the atmosphere should be filled up with refractory material, thereby completely insulating or sealing off the furnace. The rate of cooling is extremely important, especially in the range 730 to 700 deg. C., and care is necessary to ensure that it does not exceed 7 deg. per hr. through this range, and preferably slower than this rate. Furnaces may be so small that the cooling rate is in excess of that desired, but it may be retarded by relighting the furnace when the temperature has fallen to 730 deg. C., and gradually reducing the fuel supply so that it takes up to 10 hrs. for the temperature to fall from 730 to 700 deg. C. With the larger types of furnaces this procedure is usually unnecessary, as the cooling rate is naturally slow, due to the larger bulk contained therein, but nevertheless the cooling rate should be carefully observed at the critical period as a precaution against leaking flues or faulty insulation. This slow rate of cooling is necessary in order to decompose the pearlite, which consists of alternate bands of cementite and ferrite. The cementite of the pearlite contains all the residual combined carbon, the latter being set free as temper carbon in fine, evenly dispersed nodules and ferrite, *id est* carbonless iron in which is dissolved the manganese and silicon. The structural composition of fully annealed blackheart malleable iron, then, is a matrix of ferrite to which the iron owes its ductility, and fine, evenly distributed particles of free carbon, known as temper carbon (Figs. 1 and 2). The structure of the metal in the "as cast" or unannealed condition is that of a normal white iron (see Fig. 3), *i.e.*, a cementite-pearlite structure. To obtain the condition of maximum strength and ductility, the annealing procedure must be given the correct attention.

(To be continued.)

Fig. 1.—Completely Annealed Metal. Unetched. × 50.

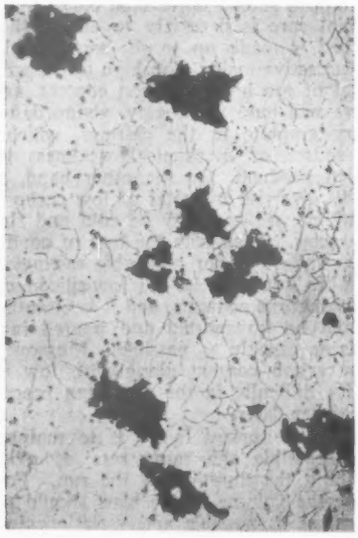

Fig. 2.—Completely Annealed Metal. Etched. × 100.

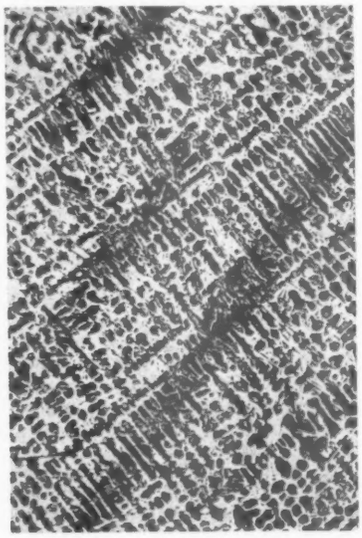

Fig. 3.—White Iron. Etched. × 50.

Catalogue Received

Trailer Fire Engines. We have received from Coventry Climax Engines, Limited, The Grange, Newbold-on-Stour, Stratford-on-Avon, Warwickshire, a quantity of trade literature, which not only describes and illustrates the various types of fire engines they manufacture, but also gives detailed operating instructions. Added interest is provided by the inclusion of a description of some of the methods employed in the fabrication of these fire engines. Being eminently suited for incorporation in the equipment of private fire brigades, the various pamphlets are of direct interest to many of our readers.

Hot-Tinning of Iron Castings

By C. E. HOMER, B.Sc., Ph.D.

(*Continued from page* 174.)

Working Temperatures and Draining of Surplus Tin

The tinning temperature has an important influence on the extent to which the molten tin drains from the articles after tinning. Adequate draining is necessary, since only a limited amount of tin can be held in a uniform layer on the surface, and any excess accumulates in thick streaks or drops (not to be confused with de-wetting) towards the lowest point. This surplus tin spoils the appearance, and since it is localised, it does not increase the durability of the coating as a whole.

In carrying out the tinning operation as described earlier, the usual working temperatures are about 280 deg. C. for the first pot and 260 deg. C. for the second.

Tallow and palm oil cannot be used successfully on the second tinning pot at temperatures much above 280 deg. C., as they rapidly char and are liable to ignite. Moreover, the vapour and smoke which they give off when overheated are liable to cause discoloration of the coating. A cover of zinc chloride may be used at rather higher temperatures, such as 300 deg. C. or over, but it tends to become hard very quickly and needs frequent renewal. Furthermore, when the tin is kept much above 280 deg. C., the articles take on a yellow colour when they are removed from the bath, due to oxidation of the coating.

Finishing

Many tinned articles require no finishing beyond rubbing with sawdust or sharps while still hot, in order to remove tallow or quenching oil from the surface. Some articles, however, particularly when tinned in one bath only, have adhering flux spots or are stained yellow by oxidation due to a high tinning temperature.

Flux spots should always be removed, since if left on the articles they deliquesce and, later, give rise to corrosion. The easiest way of dealing with them is to quench the articles in hot water, and in particularly bad cases to rub them with a rag or brush. Since a "frosty" finish is liable to result when the quenching is carried out with the coating still molten, it is often preferable to allow it just to solidify beforehand. When the spots of flux are in an inaccessible part of the article and complete removal is very important, it is advisable to add 0.5 to 1 per cent. of hydrochloric acid to the water, and follow this up by washing in plain water.

Yellow stains due to oxidation are conveniently removed by immersion of the articles while hot in a 0.5 per cent. solution of hydrochloric acid. The stain is removed in a few seconds, and with this strength of acid the tin is not etched.

If the articles are discoloured by flux, or otherwise, it may be necessary to polish them. This is carried out by rubbing them with whiting (chalk) and paraffin (kerosene), and finally cleaning them in sawdust. It should not be necessary to resort to polishing in order to overcome general dullness or lack of lustre. The brightest coatings are produced by correct tinning procedure, and no further treatment beyond the removal of oil or grease. If the coatings as produced are consistently dull or rough all over, the defect should be overcome by a change in the tinning procedure as indicated in other sections of this article.

Removal of Iron from Tinning Baths

The removal of iron from hot-tinning baths must be carried out at frequent intervals, since a very small percentage of iron causes the tinned articles to have a gritty finish. It is impracticable to use any method of separation which depends on the fact that the compound gradually sinks in molten tin if left undisturbed for several hours.

The usual procedure is based on the fact that if particles of the compound come into contact with particles or films of tin oxide, they are retained by it, and form a scum or dross which floats on the tin bath and can be removed effectively by skimming. In the method which is generally used raw potatoes or pieces of green wood are immersed in the bath. This causes a vigorous agitation or "boiling" of the tin, and the particles of tin-iron compound suspended in it are circulated rapidly. As they come to the surface, they become entangled in the oxide film formed there by contact with air, and remain floating. After a short time, a large proportion of the particles of compound is brought to the surface in this way, and a heavy pasty dross is formed, which may be skimmed off easily. The complete removal of the compound is indicated by a change in the type of dross produced. This is of a light feathery nature when it contains no entangled compound.

This method of purifying the tin should be carried out at a low temperature, about 240 to 250 deg. C., since the lower the temperature the less iron is retained in solution in the tin; it is only when the iron is present as particles of compound that it can be removed. Moreover, the type of tin oxide formed at a low temperature is more effective in retaining the compound particles than that formed at a high temperature. Before carrying out the treatment any grease or flux on the surface of the tin must be completely removed.

An alternative method is to blow compressed air through the tin bath. In this case in addition to the agitation caused by the air bubbles, particles of tin oxide are produced in the metal, and as they float to the surface they carry the compound with them. The method therefore is rather more rapid than that in which potatoes are used. It is not commonly used by tinners, partly on account of lack of facilities, and partly because the other method is much better known.

If the tin bath is regularly treated to remove iron, the above methods are all that is required to keep it in good condition. It may sometimes happen, however, that a tin bath has a considerable amount of iron in it, due to accidental over-heating or prolonged use without any purification treatment. In this case it is inconvenient to remove the iron by the methods described, since they are then rather slow. The bulk of the compound may first be separated by allowing the pot to stand for a few hours at about 240 deg. C., and then very carefully ladling out the pure tin from the top. When the pasty layer of compound at the bottom is reached, it is removed and kept separate from the pure tin. It may be treated further by maintaining it at 240 deg. C. to a deep narrow pot, when a further separation into two layers occurs. The depth of the pure tin layer is greater in a narrow pot, and it is possible to separate it more completely. The most effective way of separating the tin from the pasty compound is to use a liquation hearth, but since it is only rarely that a tin bath has to be purified by this method, it is usually more convenient to sell the pasty mixture of tin and dross to a firm of smelters.

Cast Iron

The tinning of grey cast iron is complicated by the presence of flakes of graphite in the metal, which may cause the tin coating to de-wet badly, and in some cases prevent it from adhering at all. Careful preparation is therefore necessary, and with some grey irons it is essential to apply a preliminary electro-deposited coating to which the tin will adhere satisfactorily. Malleable iron, on the other hand, is usually quite easy to tin by ordinary methods.

In the preparation of castings care must be taken to avoid prolonged pickling. Cast iron is readily attacked by acids, and if it is pickled long the surface becomes pitted and acid is absorbed around the flakes of graphite. Moreover, a sludge of graphite is left behind when the iron is dissolved, and it is often difficult to remove from the surface. For this reason it is usual to carry out most of the preparation by mechanical means, and to pickle for a few minutes only.

Either sand- or shot-blasting or tumbling may be employed, depending upon the articles to be treated and the equipment available. Since the castings produced by different foundries vary considerably as regards surface finish, it is difficult to make any definite recommendations. It may be said, however, that tumbling is generally preferred for small articles such as mincer parts, while large castings must be sand-blasted. The only requirement is that the sand and scale should be removed, and the surface left smooth and free from grease. When sand-blasting is employed care must be taken to avoid the presence of oil in the supply of compressed air.

The pickling procedure depends to some extent on the previous treatment. When the articles have been tumbled, there is generally nothing to be removed other than a thin film of graphite which has been spread over the surface by the burnishing action of the tumbling operation. This is quite easily removed by pickling for about five minutes in the usual cold hydrochloric acid solution, or for about two minutes in hot sulphuric acid. The hydrogen evolved by the attack of the acid on the iron pushes off the film of graphite. After sand-blasting, or when traces of moulding sand remain in the surface after tumbling, it is advantageous to use a cold 5 per cent. solution of hydrofluoric acid. This attacks and loosens adhering particles of sand.

Since it also attacks glass and earthenware, the pickling operation should be carried out in a vat lined with lead or rubber, and rubber gauntlets must be worn. After pickling, the castings are washed and then stored in a vat of water, slightly acidified with hydrochloric acid, until required. If the castings are made from iron which can be tinned satisfactory without further treatment, the tinning operation is then proceeded with. If, on the other hand, the iron has unsatisfactory tinning qualities, a suitable undercoat must first be applied to it.

The best coating for this purpose is electro-deposited iron. A copper coating is sometimes suggested, but is not satisfactory. If the coating is thin (*e.g.*, as obtained by chemical displacement) it is dissolved by the tin during the tinning operation and the surface of the cast iron is exposed again, particularly as the time of immersion of castings in the tin bath is necessarily longer than that employed for sheet metal, on account of their greater thickness. A relatively thick coating of copper permits of good tinning, but the tin bath becomes contaminated by copper dissolved from the plated castings and the brightness of the resulting tin coating is

impaired. An electro-deposited iron coating is, however, quite easily applied, and is not dissolved to an appreciable extent by the molten tin.

Several different baths are available for iron plating, but a convenient one consists of a solution containing 3 lbs. per gallon of ferrous ammonium sulphate. This is used with anodes of mild steel or ingot iron, and the current density on the cathode (the articles being plated) should be about 10 to 15 amp. per sq. ft. The bath is worked at room temperature, but if it falls below about 18 deg. C. the current density should be reduced. Too high a current density leads to the formation of a rough deposit at projecting parts of the article being plated. The solution has a rather poor throwing power, and for plating hollow articles it may be necessary to hang an auxiliary anode inside. Plating is continued until the casting is completely covered with a light-grey deposit of iron, which should be smooth and uniform.

The *p*H of the plating solution is important, and this tends to change in the direction of greater acidity when the bath is not being used. The acidity is corrected by adding dilute ammonia solution until the *p*H is adjusted to about 5.8, as indicated by a bromo-cresol purple indicator.

After the castings have been plated, they are tinned as soon as possible, being kept in slightly acidified water until required. The freshly deposited iron rusts rapidly if left in the air; it is also readily attacked by acid, so that the acidity of the water in the storage vat must be very low.

Fluxing and tinning are carried out by the standard procedure previously described, two pots of tin being used for the best work. Sufficient time must be allowed for the casting to reach the temperature of the tin in the first pot, but the immersion in the second pot may be quite brief.

The draining and cooling of the tinned castings call for special mention. Cast iron articles are of relatively thick section and therefore retain their heat for a considerable time after removal from the bath. If they are allowed to cool in the air the coating drains for too long a time, and the tin on the uppermost parts becomes too thin to give a bright, smooth finish. Moreover, when tinned articles remain hot for a long time the tin oxidises and becomes yellow. It is usual, therefore, to cool them by quenching in oil. Paraffin (kerosene) is suitable for this purpose, provided that the volume of oil is large in proportion to the size of the castings, and the danger of fire is thus avoided. Alternatively, a heavier oil of higher flash point may be used, this being heated to 100 to 150 deg. C. when starting work, so as to make it fluid; in this case it may be necessary to wash off the heavier oil in paraffin afterwards. Finally the castings are cleaned in sawdust or sharps.

The process described above is not used when tinning articles such as saucepans, which are only required to be coated on the inside. The wiping process is used for such articles, which are first plated with iron if the quality of the castings makes it necessary.

(*Continued from next column.*)

the mould from the top and anchored in position at the bottom of the flask by means of a nut on the threaded end of the arbour, which is drawn tight against a collar, as illustrated. This method holds the core rigidly in position.

It should be noted that this method of production was not the only one mentioned in the report; it was the one recommended as the most economical and the one with which best results had been obtained.

Method for Securing Cores in Shell Moulds*

In Papers presented to the American Foundrymen's Association in 1917-18, three general moulding methods are discussed as applicable to the production of cast shells:—(1) Green sand; (2) dry sand; and (3) permanent moulds. Because of the fact that the green sand moulding process is most widely used of the three in America, it is probably the one in which there is the most interest.

During the last war, it was recommended that cast-iron shell be made in cast-iron flasks of special design to accommodate the manufacture of four shells in a mould. A section of such a mould is shown in Fig. 1. This sketch

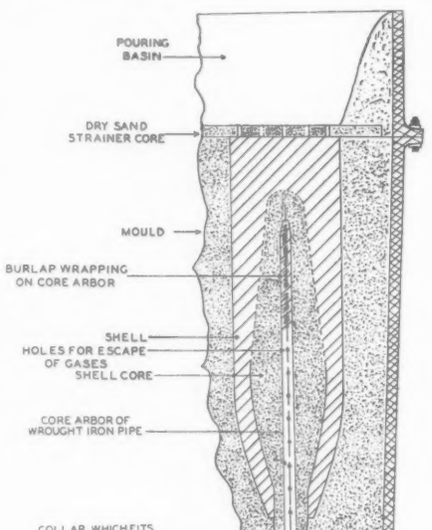

FIG. 1.—METHOD OF SECURING CORES IN SHELL MOULDS.

shows the core and arbour in position in the mould and the location of the shell casting. The approximate method of bolting the core in position also is shown. It should be noted that the arbour is wrapped with burlap strips about 3 in. wide to provide a surface to which the sand can cling. The arbour itself is made of wrought-iron pipe, or some similar material, and is provided with $\frac{3}{16}$-in. holes throughout its length for the escape of gases.

Metal is introduced into the mould through a pouring basin at the top, which serves as a cope. A strainer core is placed on top of the mould cavity and the pouring basin mounted on the core in somewhat the manner shown.

The shell is moulded in such a way that the casting stands vertically in the mould. For this type of production, it was suggested, in the report, that the best method of ramming was by jarring. The flasks were so designed and rammed that it was not necessary to roll over the flask or in any way disturb the mould after the mould was rammed and the patterns were withdrawn. The patterns were made with considerable draft, so that they could be removed from the mould easily. The core was placed in

(*Continued in previous column.*)

* Extracted from the "American Foundryman."

New Methods for Particle Size Determinations

A.S.T.M. ACTIVITIES

Two technical symposiums were to be held in Washington on March 4 and 5, one on New Methods for Particle Size Determinations in the Subsieve Range, and the second on Colour.

While there have been discussions on particle size measurement at A.S.T.M. meetings, and a number of Papers on this subject have appeared in the "Proceedings," there has been no complete session devoted entirely to this subject. It has been evident for some time that with a number of significant new developments and the growing importance of the subject to many industries, a symposium would serve a very useful purpose.

There were not many technical Papers on the general subject of colour for many years, but in 1928 Dr. L. T. Work, then Instructor in Chemical Engineering, Columbia University, now Director of Research and Development, Metal and Thermit Corporation, presented a very extensive Paper dealing with "Methods of Particle Size Determination." In this he noted the aims in fineness measurement of ground minerals, pigments, fuels, and cements, and classified various tests according to direct measurement and indirect comparison. Dr. Work pointed out that special characteristics of fineness might be stressed in each of the various fields covered. In the case of pulverised coal, for instance, extreme fines were very desirable, and requirements for pigments were diverse. The most significant factors were a minimum of coarse material desired for smooth texture and a definite amount of surface for its relation both to wetting by the vehicle and to the hiding or covering power of the paint.

The latest developments in particle size measurement were covered in the symposium, which comprised seven Papers. Absorption methods, permeability methods, sedimentation methods, and correlation of particle size measurements were covered, and the widely-publicised electron microscope was described with emphasis on its practical applications in this field. The following is the list of titles:—

(1) "New Method for Measuring the Surface Areas of Finely-Divided Materials and Its Use in Determining the Size of Particles," by P. H. Emmett (Department of Chemical Engineering, Johns Hopkins University).

(2) "Adsorption of Pigments," by W. W. Ewing (Department of Physical Chemistry, Lehigh University).

(3) "Determination of Subsieve Particle Size Distributions by Sedimentation Methods," by S. W. Martin (Research Laboratory, National Lead Company).

(4) "Shape and Surface of Fine Powders by the Permeability Method," by P. C. Carman (University of Capetown).

(5) "Methods for Determining Particle Size Distribution," by Lincoln T. Work (Director of Research and Development, Metal and Thermit Corporation), and Herbert E. Schweyer (Columbia University).

(6) "Surface Area of Portland Cement," by P. S. Roller (Physical Chemist, Eastern Experiment Station, U.S. Bureau of Mines), and P. V. Roundy, Jr. (Co-operative Fellow, American Instrument Company).

(7) "RCA Electron Microscope," by James Hillier (Research Laboratories, RCA Manufacturing Company).

THE 19TH ANNUAL MEETING of the Institution of Chemical Engineers will be held at the Connaught Rooms on April 4. It will be followed by a luncheon.

Melting and Casting Problems in the Production of High-Strength and Special-Duty Alloy Iron Castings*

By A. E. McRAE SMITH, M.A.

Under the conditions prevailing in wartime, it has been necessary for the ironfoundry industry to undertake the production of high-strength and special-duty cast irons over a considerably wider range of application than previously. This has led to much thought and consideration being given to the choice of raw materials and adaptations of existing melting plant, as well as foundry technique in producing castings to high duty specifications. Of particular importance is the choice of suitable raw materials when producing castings to B.S.S. 786, Grades II and III, and also with physical properties in excess of Grade III. Low- and medium-phosphorus pig-irons of the true Scotch type are no longer being produced in any great quantities for the ironfoundry trade, while hematite pig-iron is in short supply for high-duty and engineering cast iron.

Against this the demand for high-strength cast iron has greatly increased for special applications, in many cases as a supplementary material to replace steel castings and forgings where a non-ductile material is suitable, provided its other physical properties are well suited. Such castings, which are very often massive in section and of the "machined all over" type, call for considerable ingenuity on the part of the foundryman. Not only must he meet physical test requirements with a reasonable margin to spare, but he must also produce castings which are of uniform structure throughout and entirely free from all traces of liquid shrinkage, porosity and similar defects.

In specialised foundries some relief is found in the use of special-process furnaces, such as electric types, rotary furnaces and the like, but in the vast majority of cases the foundryman is still deepndent on the cupola. Electric-furnace melting of alloy cast iron is extremely useful, particularly for suitably balanced compositions low in total carbon. However, even to-day, the number of such furnaces is limited, and their individual capacities in iron foundries are comparatively small. Rotary furnaces of all types also have their special field of application, useful in itself, but where selection of raw materials is strictly limited, very often troubles arise which were not evident when adjustments could be readily made by a judicious use of hematite pig-iron rich in carbon. Where only phosphoric pig-irons, scrap iron, refined pig-irons and steel scrap are available, the carbon loss in many types of rotary furnaces is of such an order that it is difficult to produce high-strength cast irons of medium carbon content by this means. Therefore, it is becoming increasingly evident that the cupola still must be regarded as the best general-utility furnace for cast iron.

Advantages of Duplexing

On the other hand, much greater scope is available to the foundryman who can use electric or rotary furnaces for simple duplexing processes using cupola iron as the base material. By this means carbon control can be regulated within much closer limits than is possible in cupola melting. It is also possible to make alloy additions very accurately in the electric furnace and mix the molten and superheated charge with an accurately weighed quantity of cupola metal to obtain any desired result. Nevertheless the cupola can be and is being used very successfully to-day for the manufacture of high-strength alloy cast irons with physical properties very considerably in excess of the minima specified for B.S.S. Grade III.

As will be seen by illustrations to be given later, carbon content is the ruling factor in the attainment of high strengths in ordinary grey cast irons. Other elements, particularly phosphorus, under certain conditions, also have an important effect on this property, but in normal grey cast iron the tensile strength progressively increases, for any definite section and mass of casting, other conditions being equal, as the total carbon content decreases from, say, 3.8 to 2.4 per cent., which are the limits associated with cupola melting. In practice, highest strengths are associated with the lower end of this carbon range, and when it comes to producing grey cast iron with total carbon contents of 2.0 to 2.4 per cent. within narrow limits, melting processes other than the cupola must be used.

Experience has shown that straight cast irons in the carbon range 2.4 to 2.8 per cent., unless suitably alloyed and treated, because they have short freezing ranges and consequently poor casting properties, even when the composition is adjusted to give a suitable carbon:silicon ratio, have little application in practice. Special-process cast irons within the range 2.6 to 2.9 per cent. total carbon, either alloyed or unalloyed, cover the largest field in the manufacture of high-strength castings. When unalloyed, the carbon:silicon ratio has to be very carefully controlled to get optimum strength coupled with good castability; therefore, the cupola at first sight does not appear to be the best melting unit. In actual practice, however, cupola-melted cast irons in this range of total carbon content, when suitably alloyed and made by a technique which ensures the precipitation of graphite in a random arrangement and free from dendritic patterns, give highly satisfactory casting properties in conjunction with physical characteristics equal to and in excess of the requirements of B.S.S. 786 Grade III. In fact, probably over 80 per cent. of all high-strength cast iron with a tensile strength above the minimum of 22 tons per sq. in. called for in this specification is made in this country in cupola furnaces.

In addition, of course, for special purposes and where it is not desirable or expedient to use a total carbon content under 3.0 per cent., really high-duty cast iron with tensile strengths in the range 25 to 28 tons per sq. in. can be made with total carbon contents of 3.0 to 3.2 per cent. from cupola-melted metal. This usually entails the use of higher alloy contents, and their successful production also requires the correct distribution and arrangement of the graphite flakes in a strong matrix, a subject which will be dealt with at greater length when giving definite examples.

Essential Details in Cupola Practice

At this stage it may be permissible to consider in some detail the more important aspects of cupola melting for the production of high-strength cast irons, although the facts are so well known as to be really unworthy of repetition; yet it is proposed to take this risk of repeating obvious details because of the strongly held opinion that they are vitally important for successful production. It will be assumed that high-strength cast irons with total carbon contents in the range 2.6 to 2.9 per cent. are being produced and that they are of the alloy and special-process types, which (as already stated) combine excellent casting properties with individual strengths related to the actual total carbon content and nature and amount of the alloy in the composition.

In most processes, the use of steel scrap and other graphite-free materials is the fundamental basis of the cupola-melted material. Steel scrap in proportions up to 35 per cent. is commonly used for obtaining metal at the cupola spout containing total carbon in the region of 2.9 to 3.2 per cent., whereas in some of the patented processes where total carbon in the range 2.6 to 2.9 is sought, as much as 80 per cent. steel scrap is used in the cupola burden.

Thus the initial total carbon content charged may vary between less than 1.0 and 2.5 per cent., yet unless a correct technique is employed, the final carbon content may exceed 3.0 per cent., due to carbon pick-up from the fuel and cupola gases. When a final carbon content of 2.6 to 2.9 per cent. is required, it is necessary to control the conditions of operation which affect carbon absorption, such as speeding up the rate of melting and reducing the period of contact with the incandescent coke bed, and at the same time working the cupola in such a way that metal carrying the highest possible temperature is obtained. The main points to be observed are as follow:—

(1) *Selection of Suitable Quality and Type of Steel Scrap.*

The melting of steel scrap at temperatures available in the cupola, which are below the melting point of mild steel, is only made possible by the rapid absorption of carbon by the steel when in contact with the hot coke and carbon containing gases in the cupola. This absorption of carbon causes a considerable reduction in the melting point, and the carburised steel ultimately reaches a condition when it is readily melted in the melting zone of the cupola. Consequently the steel scrap selected (which should be plain carbon steel) must be of moderately thick section, certainly not less than ¼ in. For example, thick plate cuttings, railway rail ends, fishplates, bar ends, constructional steel croppings, etc., are all suitable for cupola melting. Very thin sheet scrap, on the other hand, tends to burn and become heavily oxidised before it reaches the melting zone. So, also, large flat surfaces of whatever thickness tend to form a baffle across the cupola and thus hinder the passage of gas in the cupola stack. The general size of steel scrap to be used, independent of thickness, will, of course, depend on the diameter of the cupola. For example, in a cupola lined to 36 in. internal diameter, lumps of steel greater than 15 in. in length should be avoided.

(2) *Attainment of High Tapping Temperatures.*

Although excessive superheating of molten cast iron may have disadvantages, the highest temperatures possible in the cupola will not reach this point. The chief source of failure is due to using metal which is at too low temperatures both as tapped and as poured into moulds. Cast iron with total carbon between the limits 2.6 to 2.9 per cent. has a comparatively short freezing range, particularly when the composition is near the lower carbon limit. Consequently, even with suitably balanced compositions, there is great danger of unsoundness due to trapped air and gas, caused by premature freezing, unless the casting temperature be sufficiently high.

If the following simple precautions are taken, suitably high temperatures can easily be obtained

* Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. W. Holland presiding.

with great regularity in high-strength cast iron melted in most cupolas.

(*a*) It is necessary in order to preheat the first charges and to obtain hot metal in the first taps to use a high coke bed. Depending on the internal diameter of the cupola, this should not be less than 36 in. above the centre line of the tuyeres, and may with advantage be as high as 48 in. in cupolas under 40 in. internal diameter. This is always assuming that the operating conditions are correctly adjusted to the particular diameter of cupola employed.

(*b*) The size of charge should be adjusted to the diameter of the cupola. In order to obtain optimum melting conditions in any cupola a fixed coke charge should be used, based on giving a depth of charge or "split" coke of 6 to 8 in. This is the ideal thickness of the layer of melting coke, and consequently the weight of the metal charge should be adjusted to suit this. For ordinary grey cast iron containing no steel scrap, the weight of the charge should be approximately 12 times the weight of the coke layer, and it should be progressively reduced, probably to eight times, as the amount of steel in the charge varies from zero to 80 per cent. This is to allow for the amount of carbon absorbed by the steel scrap from the fuel. For example, a charge containing 80 per cent. steel scrap may dissolve as much as 2.0 per cent. of its carbon from the fuel, which means about 44 lbs. of carbon for each 1 ton of iron, or approximately 50 lbs. of coke.

From the above it will be seen that in dealing with high steel mixtures the weight of the individual charges will usually be considerably less than normal. The use of comparatively small charges, *e.g.*, 8 cwts. for a cupola lined to 48 in. diameter, when using a particular density of coke has other advantages apart from the promotion of high-temperature metal. It usually allows for the collection of at least two or more charges of metal in any one ladle prior to casting moulds. This ensures regularity of composition by adequate mixing.

It is noticeable that in many foundries it is normal practice to use a low coke bed and an excessive amount of coke for the "split." When the metal is not as hot as desired, additional coke is added between charges. In most cases this does more harm than good because the amount of charge coke is already excessive.

In recommending the above practice, which has been proved effective under widely varying conditions of cupola construction, it is of course obvious that the first one or two charges will show a much higher carbon pick-up than later charges. Thus it is advisable to use the first few charges as compositions with a total carbon content above 2.9 per cent. Alternatively, the first charges may consist of 50 to 80 per cent. steel scrap, the balance being scrap iron or pig-iron which, with suitable additions of ferro-silicon and ferro-manganese, form an ideal type of cupola-melted, refined or "diluted" pig-iron. In fact this method of using up what are to all intents and purposes "wash-out" charges is a very useful one under present conditions.

(*c*) The charges should be preheated in the cupola stack for a reasonable time. Full advantage should be taken of the cupola stack for preheating purposes, by allowing the charges to soak for a period of not less than one hour, after the bed has been well ignited and before the blast is turned on. Unfortunately, in many cupolas, the height from the tuyeres to the charging door is much too short to allow of full advantage being taken of preheating by the hot gases passing up through the cupola shaft. This is particularly noticeable in the case of most cupolas built for the light castings trade accustomed to melting nothing but light scrap and high-phosphorus pig-iron. A suitable height between the top of the tuyeres and the bottom of the charging door would be a minimum of 15 ft., but it can with advantage be greater than this even in comparatively small cupolas.

(3) *Tapping Technique.*

If the total carbon content is to be controlled between 2.6 and 2.9 per cent. with an optimum range of, say, 2.7 to 2.8 per cent., then it is obvious that the time allowed for the metal to be in contact with the coke bed must be controlled. In general terms the longer the metal is in contact with the coke in the cupola well, the higher the carbon pick-up. When the melting rate is fast the carbon pick-up will be lower. The type of coke being used also has a very important bearing on the amount of carbon pick-up. For example, hard, dense cokes, high in ash, are less soluble than open, low-ash cokes with large cellular structure. Therefore, in order to control carbon content, all the above factors must be standardised for each individual cupola before a system of tapping control is decided upon. Then, from experience of the particular group of conditions applying to the production of high-duty cast iron of low total carbon content in an individual cupola, a time interval can be established. This may range from continuous tapping at almost the same rate as the cupola is melting up to tapping intervals corresponding to the time it takes to fill the well completely. Normally, tapping at comparatively short, but precise, intervals gives the required carbon content for any one steel-bearing mixture.

All the above suggestions are based on the assumption that such details as ratio of tuyere area to melting-zone area, blast volume and pressure, distribution of air supply in stack, etc., are reasonably normal.

The New Technique

Now, having established the correct cupola technique to obtain a base composition with controlled carbon content, alloy additions with or without special treatments, such as late silicon additions or so-called inoculation, may be carried out on the metal at the cupola spout. It is impossible in a Paper of this kind to go into the exact details of special-process high-strength cast irons which are the subject of Patents, but in most cases, the broad principles are based on carbon control, with a balanced silicon content and the formation of random graphite patterns.

Some 20 years ago, close silicon control was the pet hobby of most foundrymen, and attempts to make so-called strong cast irons usually depended on obtaining the lowest possible silicon content, consistent with grey machinable structures in the sectional thicknesses being handled. Nowadays, fortunately, with the introduction of inoculated or graphite precipitation types of cast iron, it is possible to have a very wide latitude in silicon content without loss of strength, if the total carbon content be sufficiently low. Cast irons of low total carbon and low silicon have notoriously bad founding and casting properties, due to extremely short freezing ranges. On the other hand, special-process cast irons with total carbon in the range of 2.6 to 2.8 per cent., or even less, provided they have a silicon content well in excess of the minimum required to make them wholly grey, and that silicon has been added in the correct manner to the correct type of initial base charge, are very easily handled in the foundry, and their castability is good.

The Sphere of High-Duty Irons

Much use has been made of high-duty cast iron to meet the requirements of Grades II and III of B.S.S. 786, and particularly of cast iron to have physical properties well in excess of the Grade III minima. These grades of cast iron have found an extremely useful field to replace and be supplementary to steel castings and steel forgings for which a high-strength material of a non-ductile character is suitable. Before giving examples of such uses, it cannot be too strongly stressed that even the strongest grades, with tensile strengths of 30 to 35 tons per sq. in. on the 1.2-in. dia. bar in the as-cast condition, are to all intents and purposes non-ductile materials. It is true that certain types have a high resistance to shock as measured by various forms of single-blow impact tests —in fact, this may reach a figure three or four times that obtained from an ordinary engineering grade of phosphoric cast iron—but, even so, this impact value is in no way comparable with that of steel or malleable castings. In the same way, the degree of ductility exhibited is scarcely measurable. Nevertheless, they do fill a very important role, particularly under present conditions.

Available Materials

It may be worth while for a moment to consider the various grades and types of cast iron which are available, confining attention to those possessing physical properties to meet the requirements of 786 Grade II and upwards. It is not intended to give exact compositions and processes, but to give indications of the most suitable, and at the same time most economical, grade to meet various applications and degrees of strength, etc.

Table I gives a brief summary of some types of cast iron available as everyday production according to the present state of knowledge. All the tensile strength figures quoted are for the 0.875-in. dia. bar, but in the higher grades the decrease due to sectional gradient is not nearly so great as in ordinary cast irons. Therefore almost identical figures would be expected for the 1.2-in. dia. bar and there should be little drop even on the 1.6-in. and 2.1-in. dia. bars.

The cast irons suggested can all be made in the cupola, although the same and similar materials can be made in rotary and electric furnaces and by duplexing processes.

With regard to actual applications, cast irons to meet 786 Grade II are being used generally for medium-duty applications, such as machine tool castings, pressure-tight castings and castings for the electrical trade where something better than high-phosphorus cast iron is necessary.

General Utility High Strength Irons

Amongst Grade III materials, Ni-Tensyl iron in particular is being very extensively used where tensile strengths in the order of 22 to 25 tons per sq. in. are required with some increase in shock-resistance over good-class engineering cast irons. As a material to replace and supplement steel castings and forgings it has been used for some very interesting applications. When alloyed with a small percentage of molybdenum in the range 0.4 to 0.6 per cent., its strength and shock resistance can be considerably increased. These grades with tensile strength in the range 22 to 26 tons may be described as general-utility high-strength cast irons. Standard compositions may be modified to meet special requirements, *e.g.*, for highly-stressed gears, nickel-chromium-molybdenum Ni-Tensyl irons are in many cases very suitable. Their wear resistance is excellent and machinability good. Their range of application is too wide to give in detail, but it will be sufficient to indicate that they are being regularly used for motor-vehicle castings, diesel engines, high-

pressure castings, pumps, machine-tool castings, dies, gears and all forms of highly-stressed components where, from experience, it is found that some type of cast iron is the most suitable material. One great advantage to the engineering trade is the ease with which Ni-Tensyl iron and similar irons may be cast into complicated designs, without after-treatment, thus ensuring speedy deliveries. Their production can be carried out in any reasonably equipped foundry possessing a cupola which is capable of giving high temperature metal. They may, of course, be heat-treated to give higher hardness and greater strength. In most types of castings beneficial results are obtained by giving a stress-relief low-temperature or artificial ageing treatment.

Acicular or Pseudo-Martensitic Structures

In the range of really high-strength cast irons, the most recent development has been the production and application of nickel, molybdenum and nickel-chromium-molybdenum cast irons with acicular or pseudo-martensitic structures.

Cast irons of this type can be produced in routine practice with tensile strengths of 26 to 35 tons per sq. in. in the total carbon range of 2.6 to 3.0 per cent. Much lower total carbon contents were at one time considered to be essential to obtain castings with physical properties considerably less than this, and electric-furnace irons held the field as being the ultra-strong cast irons, sometimes with a total carbon content as low as 1.8 per cent. and bordering on the steel castings range. Here the author is dealing with high-strength cast irons with a minimum carbon content of, say, 2.5 per cent. and capable of being produced in the average cupola.

TABLE I.—*Types of Cupola-Melted Cast Irons of High Tensile Strength.*

B.S. Specification.	Tensile strength. Tons per sq. in. on 0.875-in. bar as cast.	Approximate range of composition and process.	Remarks.
786 Grade II— For medium and heavy sections	18 (min.)	T.C. 2.9 to 3.2; Si. 1.2 to 1.6; Mn. 0.7 to 1.0; P. 0.3 to 0.6; Ni. 1.4 to 1.8	Typical low-alloy cast iron. In order to obtain this T.C. range, steel scrap is normally used in base charge.
For light sections	18 (min.)	As above but increase Si to 2.0 to 2.4 per cent.	As above, but best to use some form of late silicon addition.
786 Grade III	22 (min.)	(1) Special-process cast irons such as Ni-Tensyl iron and Grade A Meehanite, etc.	Alloy cast irons made by inoculation processes.
		(2) Low Ni-Mo cast iron to following range of composition: T.C. 3.0 to 3.2; Si. 1.2 to 2.0; Mn. 0.7 to 1.2; P. 0.30 (max.); Ni. 1.5 to 2.0; Mo. 0.4 to 0.5	Cupola-melted cast iron, which may be produced without addition of steel scrap and without inoculation.
In excess of 786 Grade III	25 to 28	Special-process cast irons with addition of molybdenum, *e.g.*, standard Ni-Tensyl iron with 0.5 per cent. Mo.	These irons will normally have pearlitic or mixed pearlitic and acicular structures.
	28 to 35	Nickel-molybdenum cast irons made by special process or otherwise, but with T.C in range 2.7 to 3.0 per cent. with 2.0 to 2.5 per cent. Ni and 0.8 to 1.5 per cent. molybdenum. Phosphorus not over 0.2 per cent.	Special-process and other cast irons with acicular or pseudo-martensitic structures. Possess high impact values.

Latest developments reveal the fact that cast irons of this type depend on the formation of an acicular or pseudo-martensitic structure for their high strength and also for their remarkable resistance to shock, although they must still be classified as non-ductile materials.

How Molybdenum Functions

This development has been due in great part to the use of small amounts of molybdenum in cast iron, but unfortunately the effect of molybdenum as an alloy addition to cast iron has sometimes been misunderstood in British foundries. Molybdenum is neither a graphitiser nor a strong carbide former, but by reason of its matrix-improving qualities, it greatly increases the tensile strength of any grade of cast iron. The effects produced by molybdenum alone, although very striking, are rather drastic, and it has been found from practical experience that combinations of nickel and molybdenum produce the maximum beneficial effect on the physical properties of grey cast iron.

In correctly-balanced proportions, added to a suitable base composition, nickel and molybdenum impart to cast iron the maximum tensile and transverse strengths and deflection so far achieved in any material which is a true grey cast iron. Probably more important is the fact that this type of high-duty cast iron, when possessing an acicular structure, has a very high degree of shock resistance as measured by single-blow impact tests.

It will appeal to the practical foundryman, the metallurgist and foundry executive (who, after all, are the people responsible for production, if the engineering trade is to obtain its supplies of high-duty cast iron easily and economically) that this type of top-grade high-strength cast iron can be produced in any standard cupola, as installed in 95 per cent. of the foundries in this country.

Acicular structures are a function of molybdenum as an alloy constituent of cast iron, yet straight molybdenum cast irons have been found to be somewhat difficult to handle in the foundry when produced from cupola-melted metal. So far as present personal knowledge goes when dealing with cupola-melted irons, 1.0 per cent. molybdenum and upwards is necessary to produce an acicular structure in cast iron with a carbon content of 2.6 to 2.9 per cent., silicon being adjusted to suit the mass and sectional thickness of any particular type of casting. Phosphorus has a very definite influence, and may cause the formation of laminated pearlite, instead of acicular pearlite if over 0.15 per cent. in straight molybdenum irons. It is known, however, that with the normal carbon contents obtainable from cupola-melted metal, the molybdenum content may be reduced to 0.7 per cent.

(*Continued at foot of next column*)

Power Consumed in Pulverising Coal

The Annual Report of Research and Technologic Work on Coal, for the fiscal year 1940, issued by the United States Bureau of Mines, refers to a study of pulverised coal and its preparation. It is pointed out that contrary to general belief the ash-bearing constituents are not always most resistant to crushing, as was shown in tests of coal constituents—that is, vitrain, clarain, durain, and fusain—from the Southern Illinois field. The net power consumed in crushing the constituents from minus 20-mesh to minus 150-mesh, with their ash content are given in Table I.

TABLE I.—*Power Consumed in Pulverising Coal Constituents.*

Coal constituent.	Fusain.	Vitrain.	Clarain.	Durain.
Net horsepower-hours per ton of minus-150-mesh product..	1.8	3.8	5.1	13.6
Ash, per cent. ..	15.6	2.2	8.3	5.2

It is shown that the durain, the hardest constituent, contains less ash than the clarain. Although comparison of the values for fusain with any of the others is even more startling it has been recognised that fusain is the most easily crushed constituent, in spite of its relatively large percentage of ash. Tests of washed coal from a mine in the northern part of the Warrior field, Alabama, showed this same characteristic; that is, the low-specific gravity material and relatively low ash required 20 per cent. more power for pulverisation than did the higher-specific gravity and relatively higher-ash material.

Metallic Abrasives

As a result of experiments carried out at the request of the Ministry of Supply (Iron and Steel Control), the Association of British Shot and Grit Manufacturers have decided to reduce the large number of varying grades or sizes of "metallic abrasives" used in shot-blast apparatus to a maximum of six standard grades which are calculated to give the most effective operational results. The new system of gradings will secure greater efficiency and economy in production. The old and new gradings are:—

New Gradings		*Old Gradings*
A	corresponding to	8—10
B	" "	12—14
C	" "	16—20
D	" "	24—30
E	" "	40—50
F	" "	60 and fines

Round shot will continue to be available graded in the usual sizes.

It is hoped that all users of metallic abrasives will co-operate in this matter in the national interest, and if they experience difficulty in changing works procedure to meet these conditions the services of experts of both shot manufacturers and blast plant manufacturers will be available to assist them.

(*Continued from previous column.*)

when 1.5 per cent. nickel is present, the phosphorus content being still about the 0.15 per cent. level. Such compositions ensure the formation of the acicular structure without risk of the formation of sorbite when higher percentages of molybdenum are used alone.

Thus a typical composition for cupola-melted metal would be:—T.C, 2.7 to 2.9 per cent.; Si, 1.8 to 2.5 per cent. (according to section thickness); Mn, 0.8 to 1.2 per cent.; S, 0.12 per cent. (max.); P, 0.15 per cent. (max.); Ni, 1.5 to 2.0 per cent., and Mo, 0.7 to 0.8 per cent.

(*To be continued.*)

The Randupson Process*

By W. PARKER

Development

The Randupson process of cement moulding, which carries British patents, was invented by a French engineer, M. Durand, and the special technique necessary for its efficient use has been developed by the Société de l'Electro-Chemie et de l'Electro-Metallurgie et des Acièries Electriques d'Ugine, at Ugine, France. It has been in active operation in foundries in France, Britain, America, Germany and Italy for several years. The use of cement-sand mixtures for cores was advocated as early as 1897, while Moldenke makes mention of its possibilities in his textbook on ironfounding. Unfortunately, appreciation of this mixture of cement and sand never passed the experimental stage, until M. Durand developed the process, which is fast gaining popularity in this country, particularly to-day, when highly-skilled moulders are becoming scarce. Castings up to 68 tons have been successfully made by the Randupson process.

General Consideration

The process differs greatly from ordinary moulding methods, and must on no account be confused with moulding in synthetic sands, where merely the characteristics of ordinary moulding sand are produced. Neither is the Randupson process one of permanent moulds, as each mould is used but once. The moulds made by Randupson are very much stronger and more permeable than normally-produced moulds, and this higher mechanical strength does away with the need for moulding boxes. Thus, castings up to 50 to 60 tons weight are regularly being cast without the moulds being enclosed in any way. Due to the extremely high permeability, trouble due to trapped gases (*e.g.*, blown castings) is considerably reduced, while the high mechanical strength prevents scabs and washing. No trouble is experienced with contraction, and the ordinary method of constructing cores is employed, an advantage being that pieces of old mould can be used for filling the interior of moulds and cores, in place of the more usual cinders or coke.

Materials

The moulding material has as a basis silica sand and Portland cement, and is thereby highly refractory, so that both light and heavy steel castings can be cast in moulds having no refractory wash. On account of the greater fluidity of cast iron, phosphor bronze and other alloys, moulds receiving these metals are usually blacked to give a smooth surface. Briefly, the process consists of the use of silica sand, above 60 mesh, mixed with from 3 to 12 per cent. cement, dependent on the class of work, the type of sand and the alloy, with the addition of just enough water to secure sub-hydration of the cement.

Moulding and Setting

The above outlined mixture is rammed round a pattern or in the core box in the usual manner, and in the case of heavy moulds is suitably reinforced with straight iron rods. Lifting staples are embedded, the entire mould being enclosed in a rough wooden chassis. After turning out the pattern, and removing the chassis, the mould is put aside to harden for a period of from 18 to 48 hrs. This setting time depends to a great extent on the exact composition of the material and temperature conditions in the shop. The impression that warm, dry atmospheric conditions are essential will be corrected when consideration is given to the fact that the Randupson process is in successful use in countries of varying climatic conditions. A minimum of 45 deg. F. in the shop should furnish no necessity for even the largest mould to take longer than 48 hrs. setting time, and 36 hrs. should be sufficient to cast in the case of steel, or to black in the case of cast iron and phosphor bronze.

Blacking and Storage

Where a mould requires to be blacked, a few hours more are necessary for the blacking to air-dry, but this may be accomplished in a few minutes with the use of a skin-drier. If required, the moulds or cores will store indefinitely, thus allowing of the keeping of quantities of stock cores. Moulds up to 4 ft. square are usually turned out on wooden boards to set, while steel plates are used with larger moulds in order to eliminate warpage of the wood. After setting, the portions are clamped together and cast, suitable locating pins being employed to ensure proper register of two or more portions. The advantages of the non-requirement of box parts, and drying stoves are obvious.

Outstanding Advantages

This lies in the great saving of time obtained with the Randupson process, a saving which in practice may vary from 30 to 75 per cent. according to the type of casting. The ramming of the sand is very easy, and does not necessitate the same care as ramming of ordinary sand. The mould has only to be filled with the mixture, when it flows more readily than ordinary moulding sands. Reinforcement with straight irons is very quick, and it is not necessary to have perfect ramming round the irons, as after setting the binding between sand and iron is always very satisfactory. This part of the mould is similar to reinforced concrete. After removal of the pattern, the sleeking and smoothing of the surface of the mould is unnecessary, and very little repair of the mould by hand has to take place. Likewise, no sprigs are generally required as with ordinary clay bonded sand.

Sand Mixing and Recovery

After casting, the moulds are stripped in the usual way, and the sand recovered is passed through a simple type of crusher, after which it is desilted and used again. In the case of cast iron and non-ferrous metals, no additions of new sand are required, but new sand is used as a facing in the case of steel and high melting-point alloys, in order to secure the highest refractory properties. Any of the usual types of sand mixers are employed, but a mill in which mixing only and no crushing is done is most suitable, the time required being in the region of 1½ mins. Setting or hardening of the moulds can be accomplished in the ordinary manner in a stove in the case of urgent work, when a temperature of about 140 to 180 deg. C. should be used. These moulds would then be ready for casting in the same time as would be the case with similar moulds in ordinary sand. This may be from 4 to 24 hours, according to the mass of the mould.

Disadvantages

Naturally, as with all other processes, there are some disadvantages in comparison with ordinary moulding. First of all, there is the inability to make and cast in the same day, so that provision must be made for storage until set. This is naturally a factor of the class of work being done, and of the cycle usually involved in making a mould. The pattern with the Randupson process is released for re-use much more quickly. An example may be quoted of an intricate casting, which normally requires two moulders to make it in one week. Employing the Randupson processes, it can be made in one day by one moulder with three labourers, so that six castings can be made in a total time one-third that of ordinary methods. As already mentioned, castings up to 68 tons weight have been successfully produced in iron, steel and non-ferrous materials.

Another disadvantage is that the "life" of the sand-cement mixture is only 3 to 5 hours, so that all the mixed sand must be used within that period. The third disadvantage is that, in the green state, the sand has little or no bond, and moulding methods must be designed to eliminate the necessity for lifting the mould before setting.

At this point, it must be made clear that the Randupson mixture can actually be used in and among the normal foundry sand, which it improves and opens up. The fourth disadvantage is that, in ironfounding, the sand costs are usually higher than those in normal practice, since the whole of the sand has to be mixed and cement added. This is far outweighed by the saving in labour costs, as is very obvious after a careful study of the process in operation. With steel founding, the total sand costs are lower, as the silica sands used are much cheaper than imported Continental sands and moulders' compo. This latter may be dispensed with, since the Randupson process handles effectively the heaviest casting. Again, where expensive loam-sand mixtures, transported from a distance, are used, the sand cast of Randupson may actually be less. Preparation is much simpler, composition is regular and is equally suitable for mould and core alike.

Much less skill is required even in complicated moulds, because of the facility with which the process can be adapted to modern working methods, such as the making up of the mould in several easy parts, strickle work, and the use of skeleton patterns, especially for large moulds. Castings made by the Randupson process are much truer to pattern than those made in the ordinary way, due to the high mechanical strength of the cement-sand mixture, while this latter property in no way increases fettling and dressing costs, since the heat of the molten metal breaks down the cement bond in the sand adjacent to the casting.

Application

The Randupson process can be applied to any casting normally made in dry-sand mixtures. It can be struck up in a similar manner to ordinary sands and loam, and practically all moulding methods can be operated with cement sand as used by the Randupson process. Silica sands are available in all parts of the country, and the mixture is easily varied to suit local sand properties. While castings normally made in green sand can be dealt with, it is not advisable to apply the process in this field with a view to a saving in cost. Nevertheless, no increase in cost over green-sand work is found when the process is adopted. A point to be emphasised is that the process is not suitable for light castings, such as made in the Falkirk district.

DISCUSSION

The CHAIRMAN (Mr. Alex. Cunningham), opening the discussion, mentioned that he had seen no evidence in the slides of any ribs, because in compo practice they were used to prevent the tearing of the mould. He would also welcome some information as to whether Randupson castings were as sound as normal castings.

MR. PARKER said that ribs were not necessary, because the cement bond broke down readily in contact with the molten metal. Cores in Randupson practice were usually hollow, and in the region of 1½ in. thick. The soundness of

(*Continued on page* 196.)

* Paper read before the Falkirk Section of the Institute of British Foundrymen, Mr. Alex Cunningham presiding.

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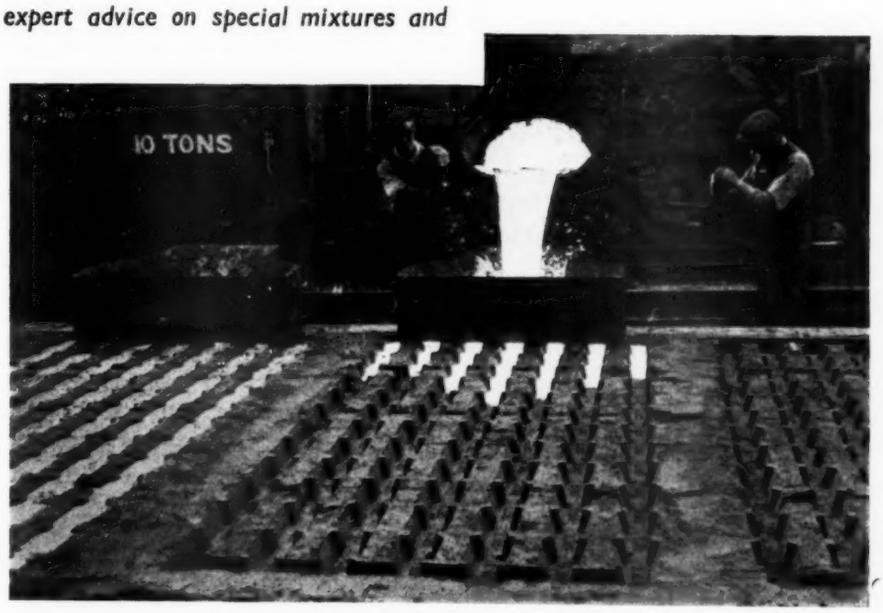

THE STANTON IRONWORKS COMPANY LIMITED, NEAR NOTTINGHAM

A Record Heavy Casting?

A 200-TON ANVIL BLOCK

By ARTHUR SUTCLIFFE

Following an excellent Paper by Mr. J. Roxburgh which covered the field of heavy castings, the writer asserted that he would furnish details of a casting made in Bolton which exceeded by quite a margin the heaviest ever made in Sheffield. The object of this article is a fulfilment of the promise then given. It relates to an anvil block and foundations for a 25-ton steam hammer erected at the Bolton Steel & Iron Company's works in 1867.

The anvil block of 210 tons weight is probably the heaviest casting which has ever been made in this country. This block formed part of the equipment of a steam hammer used at the Bolton Iron & Steel Company's works at Bolton, and was made by Nasmyth, Wilson & Company. The hammer-head was 25 tons, and the stroke 9 ft. The block was a casting 12 ft. square on the base by 11 ft. 6 in. high, and it was cast at a horizontal distance of 16 ft. from its working site, in an inverted position.

Melting Equipment

The casting was made by the aid of two of Ireland's patent cupolas, and the operation was conducted under the direction of Mr. J. Ireland, who had great experience in this class of work. The two cupolas used at Bolton had wrought-iron casings 7 ft. in diameter and were 22 ft. high; and the charging doors were 15 ft. above the ground level. The furnaces, when bricked up, were 3 ft. 8 in. inside diameter across the tuyeres, widened out below to 5 ft. 6 in., and above to 5 ft. There were twelve tuyeres in each furnace—four at the bottom, each of 8 in. dia., and eight upper ones, each of 3 in. dia. The blast was supplied from the blowing engines used for the Bessemer process, and it was conducted to the furnaces through cast-iron pipes 15 in. in diameter. The pressure at the furnaces was equal to a water column 14 in. high.

Process Details

In commencing operations, the charges consisted of 50 cwts. of metal to 3 cwts. of coke; and for the first 50 charges, from 3 to 4 cwts. of scrap Bessemer steel were put in along with each charge, in addition to the above-mentioned weight of iron. In the afternoon the proportion of coke in the charges was reduced to 2½ cwts. for the same weight of metal. The two furnaces were each filled with melted iron up to the level of the tuyeres before the first tap was made, and throughout the operations the iron was allowed to accumulate in the same manner before being tapped.

There were runners from the furnaces to the side of the mould, where a perpendicular gate was formed down to one of the two trunnions, which were cast on the block. The metal thus ran into the mould through the trunnion; all the metal was run in in this way, and none over the top. The effect of this method of proceeding was that each fresh lot of metal run in after the mould had been filled up to the level of the trunnions filled up through that previously poured, and the whole mass was thus kept in a molten state until the mould was full.

The total time occupied in melting was 10¾ hrs., including 2 hrs. of stoppage, during which the blast was shut off. The time actually occupied in melting the required quantity of iron was thus 8¾ hrs. The mould was built up of brickwork lined with loam, and it is thought that nothing was placed at the bottom of the mould to break the force of the falling iron. A large quantity of charcoal was put into the mould before pouring the metal, and this floated on the latter and kept it from chilling. The brickwork of the mould was not removed for a month after the casting was made, although the sand was dug from around it the week after the metal had been run.

Inverted Position of Casting

The block was cast bottom upwards; and after the mould had been removed, and the necessary space cleared, brick walls and bearers were built up under the trunnions already mentioned, and the casting was then turned over on these trunnions so that it hung bottom downwards. The trunnions were each 1 ft. 6 in. in dia. by 3 ft. long, and they were situated at a distance of 7 ft. 4 in. (measured to their centres) from the base of the block; so that, when the latter was in the inverted position in which it was cast, there was a great preponderating weight above them. After being turned the right way up, the block was moved horizontally 16 ft. into its working position, where it was bedded in a thick layer of concrete and a cement made of iron borings and sal-ammoniac.

The Bolton Steel Works were dismantled about eight years ago by T. W. Ward, Limited, to create a new market place and motor 'bus station.

The Randupson Process

(*Continued from page* 194.)

the casting was at least equal if not superior to that associated with a normal sand mixture. He would also mention that any kind of silica sand, free from bond and over 60 mesh, was satisfactory for this process.

MR. R. R. SHAW asked if the new cement added after crushing the old mould was always the same percentage. Was there any likelihood of vitrification with, say, large steel castings?

MR. PARKER said that slightly less new cement was added in each reconditioning, while as regards vitrification he had seen no evidence of this, even with a casting over 60 tons in weight.

MR. T. R. GOODWIN (hon. secretary of the Section) said that Mr. Parker had remarked during the showing of the slides that a very high permeability could be obtained even when using as much as 15 per cent. cement. Would not such a high percentage of cement irritate the skin of the workers? Again, was Portland cement the only suitable brand for the process? Was there any need for a special type of pattern, and did castings made by this process chill more readily than those made in ordinary sand? Finally, what standards were employed in considering what types of casting could be economically made by the process.

MR. PARKER, in reply, stated that the degree of skin irritation was negligible. The most suitable type of cement for the process was really Ciment Fondu, which was a good binder and spreader and which gave a mixture which flowed better and was thereby easier to ram. Good results could be consistently obtained by using either this or Portland brand, as already mentioned. Other types of English cements were not so good, being usually much finer. The patterns used should be of the split type, while very little additional chill was experienced with the resulting castings. In reply to Mr. Goodwin's final question, Mr. Parker said that any casting normally made in dry sand was a potential Randupson process casting, but castings which were being made perfectly in green sand should not be counted as such.

MR. JAS. MACKINTOSH asked whether there was any additional suction experienced when drawing hollow patterns, such as for boilers, from a Randupson mould.

MR. PARKER stated that this was not so, especially as the patterns were usually painted with cellulose to prevent any sticking.

The discussion was continued by other members, after which, on the proposal of the chairman, Mr. Parker was accorded a very hearty vote of appreciation.

Book Reviews

Cutting Tools for Metal Machining, by Max Kurrein and F. C. Lea. Published by Charles Griffin & Company, Limited, 42, Drury Lane, London, W.C.2. Price 16s.

Although the literature on cutting tools for metal machining is extensive this is the first comprehensive textbook, dealing with the subject. The book is divided into fourteen chapters and is copiously illustrated. As might be expected the first chapter deals with the elements of the tool and after defining the cutting edge the authors proceed to deal with compound cutting edges, the measurement of cutting angles, chip formation, cutting forces, dulling of the cutting edge and cutting speeds and feeds. The second chapter is devoted to a consideration of materials for tools. Chapter IV is particularly comprehensive and is devoted to turning and boring tools. This is followed by chapters dealing with drilling tools, counter bores, reamers, threading tools and milling cutters. The book concludes with chapters devoted to tool grinding and tool hardening.

In view of the eminence of the two authors the book is as a whole disappointing. There are a number of contradictory statements which will confuse the student whilst omissions and mis-statements will tend to make anyone skilled in the art of metal cutting suspicious of the whole work. In the first paragraph of the first chapter there is a contradiction. In one sentence it is categorically stated that the cutting edge proper of reamers is straight whilst the next sentence states with the same clarity that it is partly straight and partly curved. The matter is not properly clarified until one arrives at Chapter VII where the different types of reamer, some of which may have straight cutting edges and other spiral cutting edges, are properly described. In the first paragraph of Chapter I it is also definitely stated that the cutting edge proper of a lathe tool is straight but in Chapter IV, Fig. 65 shows a selection of typical lathe tools, many of which have curved edges and bear such designations as curved nose rougher, round nosed rougher, and the like. Amongst the omissions may be mentioned the absence of any reference to the built-up cutting edge and to the type of tool failure in which the edge breaks away without the prior formation of a groove behind it.

The authors have also chosen an unfortunate nomenclature for the various angles. The terms back-rake, side-rake, etc., have become so well established that it is unfortunate they should have thought fit to introduce other expressions. The use of the word "vitrified" in reference to tungsten carbide tools is also scarcely justified in view of the fact that they are so universally referred to as sintered products. The statement that tungsten carbide tools give what might be called an apparent hardness less than that of high-speed steels is difficult to understand The diamond hardness of high-speed steel is, as stated by the authors, in the vicinity of 740-800, but the diamond hardness of tungsten carbide is always well above 1,000 and upon occasion the reviewer has obtained a hardness figure of 1,500. There are, of course, many different methods of determining the hardness but he, the reviewer, is not acquainted with a single one which does not show tungsten carbide to be very much harder than high-speed steels.

Finally the matter presented in the book is not particularly up to date. Broaching, for instance, has been much further developed than one would imagine from a perusal of Chapter XI, and lathe tool grinding and heat treatment are other aspects of the art that have advanced further than one would imagine from a perusal of the chapters devoted to them.

J. FERDINAND KAYSER.

FRY'S SOLDERS

Soft Solders for Higher Temperatures

Metals suffer a progressive fall in strength as the temperature increases. The fall is particularly marked in low melting point alloys, like soft solders. Thus joints made with the ordinary tin-lead solders lose about 50 per cent. of their strength at 100 deg. C. and 75 per cent. at 150 deg. C. Where the joint is not highly stressed, these solders are adequate for units containing boiling water. Where higher working temperatures are encountered, as in header tanks, rotors and armature connections in electrical machinery, other alloys must be used, having higher melting points and consequently better strength at working temperatures exceeding 100 deg. C.

Two types of alloy are available. The lead-free tin base alloy H.T.3 gives joints stronger at all temperatures than those made with Tinman's Solder : its superiority being very marked at temperatures over 150 deg. C. In service, this solder has operated successfully at temperatures above the melting point of the tin-lead alloys.

ALLOY	MELTING POINTS		BRINELL HARDNESS (10 mm. ball (25 Kg. load 30 secs.)				
	Solidus	Liquidus	15° C.	60° C.	100° C.	150° C.	180° C.
Tin-lead eutectic Solder, 63% Tin	183° C.	183° C.	13·8	8·7	5·3	2·7	Nil
Fry's H.T.3	236° C.	243° C.	10·3	7·25	5·45	3·65	3·0
Fry's L.S.1	305° C.	310° C.	7·1	6·55	5·35	3·75	3·0
Fry's L.S.2	305° C.	305° C.	7·1	6·85	4·95	3·65	3·0

Lead-silver solders L.S.1 and L.S.2 commence to melt at 305 deg. C. have a still greater temperature margin. This is reflected in a more gradual fall in strength.

H.T.3 which is recommended for all except special work, is easy to apply, owing to its high tin content. It is fluid, "tins" rapidly, and has good electrical and thermal conductivity, qualities which make it particularly suitable for radiator and electrical work.

These solders can be used for both "bit solder" and hot dipping.

Technical leaflets are available in connection with all types of Solders and Soldering fluxes.

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No. 19

The Week's News in Brief

Trade Talk

THE LORDS COMMISSIONERS of the Admiralty give notice that they have made an Order entitled "Segregation of Aluminium Scrap and Aluminium Alloy Scrap (Admiralty) Order, 1941."

THE BOILERS (SHELL TYPE) EXPORT GROUP has been formed. Mr. W. J. Thompson, of John Thompson (Wolverhampton), Limited, is chairman, and the secretaries are Jones, Crewdson & Youatt, 7, Norfolk Street, Manchester, 2. There are 28 member-firms.

JUDGMENT WAS RESERVED by Mr. Justice Bennett, in the Chancery Division, recently, in an action for damages against the Clay Cross Company, Limited, for alleged infringement of a patent for improvements in the production of unhardened metallic castings in metal moulds. Plaintiffs were the International de Lavaud Manufacturing Corporation, Limited, of Toronto, Canada, owners of the patent, which has now expired; Cochrane's (Middlesbrough) Foundry, Limited, of Middlesbrough; and the Stanton Ironworks Company, Limited, of Stanton-by-Dale, Nottingham, sole licensees in this country for the manufacture and sale of castings made by the patented process.

THE PITTSBURGH BRANCH of the British War Relief Society, which has been organised by Mr. Oliver Smalley, O.B.E., the British Consul, has already despatched to this country £32,000 in cash, over 159 cases of knitted goods, hundreds of bundles of clothes, foods and other materials, as well as 15 mobile kitchens and seven ambulances. This information is revealed in a letter to Mr. J. A. Smeeton, M.I.Mech.E., which carries the additional information that Mr. Smalley is addressing meetings three to five nights a week.

WORLD PRODUCTION of tin in January is estimated at 17,500 tons, compared with 15,100 tons in January, 1940, according to the Statistical Bulletin of the Tin Research Institute. United States deliveries totalled 12,760 tons in January, against 9,780 tons in the corresponding month of last year. Deliveries for the twelve months ended January 31 were 118,477 tons, against 77,346 tons in the previous twelve months. Tin consumption in the United Kingdom amounted to 29,225 tons in 1940, against 27,279 tons in 1939, and 18,290 tons in 1938. World stocks of tin, including smelters' stocks and carry-over, decreased by 1,176 tons during January to 59,806 tons at the end of the month. Stocks at the end of January, 1940, were 49,370 tons.

THE MINISTRY OF LABOUR and National Service has issued leaflets entitled "Going away on War Work" and "Engineering Training for Women." The first (P.L. 83) contains a special foreword by the Minister of Labour and National Service, and provides answers to questions likely to be asked by people leaving their homes to take up war work in other areas. Points covered include the journey and lodgings, and such questions as meals, recreation and medical facilities. The second leaflet (P.L. 84) is devoted to women's training for wartime work in the engineering industry. Women are told how to apply for training, what types of courses are available, and how long training takes. The leaflet also briefly describes what engineering work is like, and deals with such questions as training allowances (including allowances for dependants) and training away from home. Copies of the leaflets may be obtained from any Employment Exchange or direct from the Ministry of Labour and National Service (Public Relations Branch), Montagu House, Whitehall, S.W.1.

A NEW ORDER for the control of employment gives fresh powers to the Minister of Labour to prevent loss of production owing to unnecessary changing of jobs and absenteeism. Under the Essential Work (General Provisions) Order, 1941, just signed, the Minister may schedule any undertaking which is engaged on essential work if he is satisfied it is expedient to do so. Any undertaking which is engaged on work essential to the war effort may be scheduled provisionally for three months at a time, but before placing an undertaking more permanently on the schedule the Minister must, after consultation with the appropriate Government Department, be satisfied on the following points: (*a*) The terms and conditions of employment of persons in the undertaking must not be less favourable than those provided for by collective agreement. (*b*) There must be satisfactory provision for the welfare of workers. (*c*) Provision must exist for the training of workers if the Minister considers this necessary. When an undertaking is scheduled the effects are briefly that: (*a*) The right of the management to discharge, and of the personnel to leave, is strictly controlled and is in general subject to permission of a National Service officer and to at least one week's notice. (*b*) A guarantee of a certain minimum time-rate of wages is given, subject to specified conditions. (*c*) Cases of alleged absenteeism will be dealt with under a special procedure.

Personal

MR. P. GARVEY, of Newport, has been elected president of the Iron and Steel Trades Confederation.

MR. N. R. REES, who has for some years acted as technical adviser to the foundries department of the Staveley Coal & Iron Company, Limited, has been appointed foundries general manager in place of the late Mr. J. B. Allan.

MR. FRANK PARKINSON, chairman of Crompton Parkinson, Limited, Derby Cables, Limited, and the British Electric Transformer Company, Limited, etc., has been granted leave of absence from his executive positions in these companies to enable him to place his whole-time services at the disposal of the Ministry of Supply on his appointment as Deputy Director-General of Contracts. Mr. Parkinson will, however, retain his seat on the board of the above-mentioned companies.

Will

BARCLAY, GRANT, of Broughty Ferry, a director of the Caledon Shipbuilding & Engineering Company, Limited £38,546

Obituary

MR. WILLIAM JOHN HUTCHINSON, proprietor of the Thurso Engineering & Foundry Company, Millbank, Thurso, died recently.

MR. RALPH HENRY HUTCHINSON, formerly resident engineer for C. A. Parsons & Company, Limited, in Russia, and later technical adviser to the Engineering Employers' Federation, died in Newcastle-upon-Tyne on March 8, following an accident. He was 74 years of age.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Richmond Metal Company, Limited, 18, Clydesdale Gardens, Richmond, Surrey—Capital, £500. Director: A. P. Mackenzie.

Sun Engineering (Richmond), Limited, 383, Richmond Road, Twickenham, Middlesex—Capital, £1,000. Manufacturers of fire-fighting equipment, etc. Directors: W. C. Latham and J. Lorton.

Contracts Open

Andover, April 7—Spun-iron pipes and cast-iron fittings, etc., for the year ending March 31, 1942, for the Town Council. The Borough Surveyor, Municipal Offices, Bridge Street, Andover, Hants.

Maidenhead, March 31—Supply and erection of pumping machinery for the Borough Council. Howard Humphreys & Sons, consulting engineers, 7, Eldon Square, Reading, Berks. (Fee £2 2s., returnable.)

Application for Trade Mark

The following application to register a trade mark has been taken from the "Trade Marks Journal":—

"SCREWCRETE"—Foundation parts of buildings, piers and similar structures, capstans and pile driving plant. BRAITHWAITE & COMPANY, ENGINEERS, LIMITED, Horseferry House, Horseferry Road, London, S.W.1.

Reports and Dividends

Baldwins, Limited—Dividend of 10 per cent. on the ordinary capital for 1940 (same).

Millom & Askam Hematite Iron Company, Limited—Dividend of 10 per cent. (same).

Hadfields, Limited—Final ordinary dividend of 15 per cent., making 22½ per cent. for 1940 (same).

Colvilles, Limited—Final dividend on the ordinary stock of 5 per cent., making 8 per cent. for 1940 (the same as for 1939).

Range Boilers, Limited—Net profit for 1940 £11,632 (against £13,997 for 1939); dividend on the ordinary shares of 20 per cent. (same).

British Aluminium Company, Limited—Final dividend of 7 per cent. (against 8½ per cent.), making 10 per cent. for 1940 (12½ per cent.).

G. D. Peters & Company, Limited—Net profit for 1940, £114,901 (against £128,793); final dividend of 7½ per cent., making 15 per cent. (for 1939 the total dividend was 30 per cent., and in addition a capital bonus of 50 per cent. was paid).

Vickers, Limited—Net profit for 1940, after providing for taxation, £1,119,120 (against £1,192,041 in 1939); final dividend on the ordinary stock of 6 per cent., making 10 per cent. for the year; to contingencies, £250,000 (£250,000 in 1939); carried forward, £651,821 (£480,188).

Josiah Parkes & Sons, Limited—Trading profit for 1940, after providing for taxation, £19,284 (compared with £13,370 in 1939); A.R.P. expenditure, £4,143; war risk insurance, £1,000; net profit, £14,141; brought in, £10,012; interim dividend of 4 per cent., £3,450; final dividend of 6 per cent., making 10 per cent., £5,175; to reserve, £5,000; carried forward, £10,528.

Clarke, Chapman & Company, Limited—Net profit for 1940, after providing for taxation, £122,469; depreciation, £22,845; brought in, £32,155; dividend of 7 per cent. on the preference shares, £4,889; dividend of 12½ per cent. on the ordinary shares, £60,000; to staff pensions fund, £5,000; to reserve, £20,000; carried forward, £38,632.

International Combustion, Limited—Profit for the year to September 30 last, £198,677 (against £299,000); taxation, £75,000; final dividend of 15 per cent. (against 12½ per cent.) and a cash bonus of 10 per cent. (12½ per cent.) on the ordinary shares, making 30 per cent. for the year (32½ per cent.); carried forward, £21,376 (against £12,209).

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

526,812 STANTON IRONWORKS COMPANY, LIMITED, CORNELIUS, F. B., and DURO, N. Reinforcement of concrete pipes and like hollow bodies.

526,815 ROBERTS, S. T., and TAYLOR, F. Rust-proofing of ferrous surfaces prior to painting or enamelling.

526,931 CORNELIUS, F. B., CORMAC, P. P. B., RUBBER CEMENT PRODUCTS, LIMITED, and STANTON IRONWORKS COMPANY, LIMITED. Protection of pipes and like hollow bodies.

527,064 HAESLER, J. J., and EISEN, C. Hard metal carbide alloys and processes of making the same.

527,202 ELECTRICAL RESEARCH PRODUCTS, INC. Permanent magnets, and alloys suitable for use therefor.

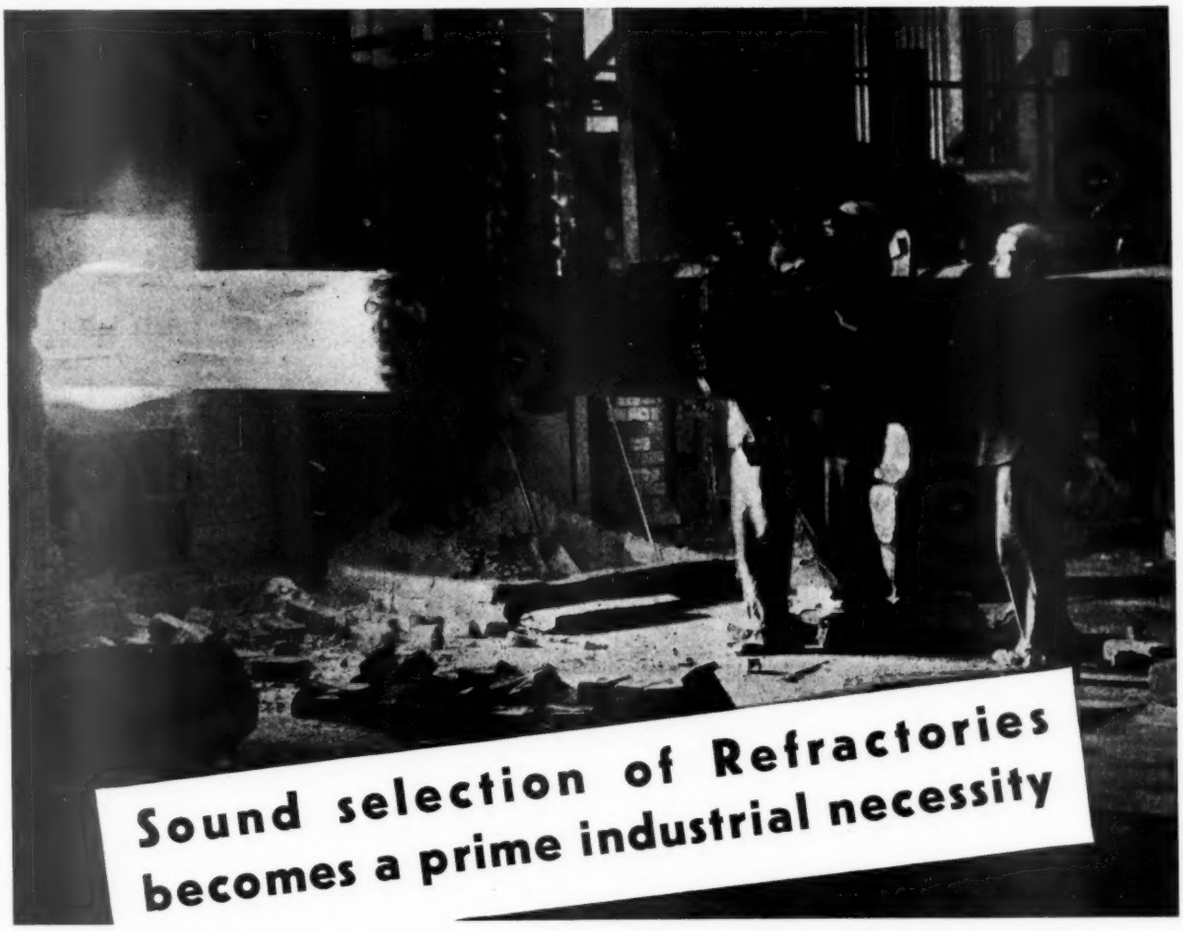
527,579 POTTS, H. E. (Electro Metallurgical Company). Silicon alloys.

527,601 DEUTSCHE EISENWERKE AKT.-GES. Protective layers for the interior of pipes and like hollow bodies.

527,751 NEALE, C. F., and KRONSBEIN, J. Means for conveying metallic articles through electro-plating or like apparatus.

527,774 BRADLEY, H., and IMPERIAL CHEMICAL INDUSTRIES, LIMITED. Hardening of steel articles.

WHEN ONLY **PRODUCTION** COUNTS



For the institutions we all hold dear, British Industry, both men and management, are working with an intensity and will-to-win unique in our history. Refractories cradle almost every item of war equipment—ships, planes, tanks, guns, and so on. Never before has the choice of suitable refractories held greater consequences. The life of furnace structures must reach its maximum, and repair time minimised. In the choice of a refractory—'G.R.' engineers can be of much assistance to you. A wealth of experience is backed by a comprehensive range of famous products, which—when selected and applied to suit service conditions—will yield maximum life and dependability. 'G.R.' invite your enquiries which will receive the most careful consideration.

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BASIC BRICKS: *Spinella, Saxpyre, Supermag, Diazite, Dolomax.*
ACID-PROOF REFRACTORIES: *Obsidianite, Losol.*

INSULATION: *Amberlite* Bricks, Cement and Concrete.
SILICA BRICKS: *Lowood, Meltham, Allen, Quartex.*
CEMENTS: *Sintex, Durax, Pyrolyte.* PLASTICS: *Durax, Rotaline, Plastic K-N., Glendoline, Ground Ganister, Steel Moulders' Compositions.* SILLIMANITE: *Tank Blocks, Bricks and Cements.* SANDS: *Moulding, Brick Facing, Silica, Glass.*

Raw Material Markets

As Government plans for expanding the nation's war effort are put into operation the demands on the iron and steel industries become more insistent. Outputs, already at high levels, are being enlarged where possible so that a big proportion of consumers' requirements may be met from home production. Imports from the United States and elsewhere are substantial, but the necessity for keeping these down as much as possible is fully recognised. Buyers are covering themselves over the second quarter of the year, and makers' order-books will be filled to capacity over that period.

Pig-Iron

MIDDLESBROUGH—Foundrymen in this district are well situated in the matter of foundry iron, adequate tonnages being delivered by Derbyshire and Northamptonshire ironmakers, who have replaced Cleveland makers in this respect. Output of Cleveland iron is irregular, and represents a minute proportion of the aggregate needs of consumers. If any delay is experienced in securing iron from the Midlands it is not due to shortage of supplies, many producers there having considerable stocks on hand, while output is on a satisfactory scale. Transport has at times interferred with the regular despatch of iron, but railways are now coping more expeditiously with traffic. Consumption is rising, but there does not appear to have been any marked expansion in production, although this could be quite easily accomplished if the necessity arose.

The hematite position remains somewhat tight, available supplies being fully taken up by the requirements of war contracts. Of course, a considerable volume of the local output is requisitioned by steelworks which have prior claims, so that the tonnage to hand for distribution to other points is restricted. In addition to meeting the calls of users in this area, makers are called upon to deal with inquiries from Sheffield and the Midlands, but these demands can only be satisfied in part. Hematite consumers are encouraged to make use of alternative types of iron where practicable, but, while this is being done extensively, large supplies of imported hematite are being taken up.

LANCASHIRE—Common irons are in fairly strong request in this area, notwithstanding the fact that light-castings makers and the jobbing foundries are not by any means operating to capacity. Heavy foundries, however, are very active, and are taking up iron in ever-increasing tonnages. There has recently been a considerable expansion in the demand for refined irons, with deliveries coming through steadily. Midland ironmakers in a few cases are behind schedule with despatches of pig-iron, but, generally speaking, supplies are forthcoming promptly. Order-books for the second quarter of the year are already well filled.

MIDLANDS—Government departments have been able to find little use for the normal range of products of the light foundry trade, but some makers have adapted their manufactures to suit the needs of these concerns and are thus better placed for work than other establishments in the trade. Requirements of the building trade and other sections using light castings are rather larger than for some time past, but are still quite insufficient to keep producers' works in full employment. In the aggregate, considerable tonnages of high-phosphorus iron are being taken up by the light-castings trade, while more of this type of iron is passing into consumption among heavy engineers, who are experiencing some difficulty with regard to supplies of better quality irons. Low-phosphorus iron is moderately satisfactory in supply, but much heavier quantities of hematite are needed by the speciality engineers. Refined iron is being incorporated in mixtures as freely as possible, but there is, of course, a limit to the extent to which this iron can be utilised.

SCOTLAND—Demand for foundry pig-iron is at a high level and is rising week by week; adequate supplies are being forwarded to works engaged on contracts associated with the war effort, but some other users are not getting their full requirements. This is especially noticeable among the light-castings founders, many of whom are busier than for months past. Builders' requirements are increasing, while some makers have received a larger share of work for the various Government departments. The needs of the steelworks are extensive and cannot be met entirely without the assistance of shipments of foreign iron. The Control authorities have arranged for the deficiency in home production to be satisfied by the release of imported iron, but the latter is, of course, distributed with the utmost care on account of the need for conserving both shipping space and foreign exchange.

Coke

Ample supplies of foundry coke are on hand at the ovens, and there are few reports of delays in deliveries, so that the position in this market is very satisfactory. Consumers, on the whole, are anxious to cover their future requirements, and this they are able to do, although no firm price can be quoted for forward business, as the Control may authorise a revision of the present quotation without prior intimation. For delivery to Birmingham and Black Country stations, the present price of Durham best foundry coke is 61s. 6d. per ton.

Steel

The desirability of maintaining British steel production at maximum levels has been re-emphasised by the Iron and Steel Controller, who has appealed to workers in the industry to ensure that outputs at their works be kept on as large a scale as possible. Ample tonnages of American semis are forthcoming to fill any deficiency in home production, and re-rollers are not hampered in this respect. All types of finished steel continue to be called for in ever-increasing tonnages, with the possible exception of products for structural engineering establishments, which have been in rather lower demand of late. Special steels for munition works remain very active, and the movement of these grades is likely to be accentuated as the various defence programmes of the Government increase in intensity.

Scrap

While scrap merchants are disposing of all available supplies as quickly as they come to hand, it is apparent that there is still some leeway to be made up before supply and demand are balanced, and there is urgent need for a speed up in the collection of scrap. Consumers are anxious to place additional orders, but unless the supply position improves a certain amount of business will have to be held in abeyance. Steelmakers have particularly heavy requirements, and are taking up all the material that is offered to them. Transport facilities have improved, and delivery delays are less due to this than was the case a few weeks ago.

Metals

Copper—Large tonnages of copper continue to be absorbed by the war machine, consumption tending to increase with the expansion of Government industrial projects. As a result, less copper is being allotted to non-essential consumers. The policy of the Control authorities to conserve the metal to meet the requirements of priority users is recognised as being a necessary measure, owing to the dependence of the United Kingdom on the steady arrival of further shipments.

The American copper market has settled down again to more normal conditions following the artificial activity caused by the disturbed political situation in the Far East, and it is felt that supplies should be adequate during the year. Latin-American copper purchased by the Metals Reserve Company is being distributed by an allocation committee led by Mr. R. R. Eckert, secretary of the United States Copper Association. Allocations were not expected to exceed 2,600 tons in February, but in March and the following seven months 25,000 tons monthly was expected to be distributed.

According to the American Copper Institute, production of crude copper in the United States in February totalled 79,093 tons, against 83,379 in January. Production of refined copper was 93,654, against 93,327; deliveries to domestic consumers, 112,808, against 119,736; export shipments, 11, against 22; refined stocks at the end of the month, 97,689, against 116,341 tons.

Tin—A fairly quiet tone has ruled in the London tin market, and activity has not been particularly notable. New tin export licensing arrangements have been introduced by the Ministry of Supply, and it is hoped in trade circles that these will assist shippers by removing the uncertainties which have confronted them of late.

Commenting on the American tin situation at Washington recently, Mr. W. A. Harriman, chief of the Materials Branch Division of the Office of Production Management of the U.S. Government (quoted by C. S. Trench & Company, Inc., of New York), said that the present unstable condition in the tin market would serve no useful purpose whatever and might have unfortunate repercussions on the defence programme and the national economy as a whole. He declared that actual supplies of tin already stored in the country and already afloat beyond any danger zone were sufficient to meet requirements at the present rate of consumption for at least 15 months without resorting to conservation or substitution. Under these circumstances, Mr. Harriman stated, buying practices which increased the price of tin were not only prejudicial to the interests of general price stability, but were extremely short-sighted. In the event of supplies of tin from the Far East being interrupted, immediate steps would be taken to conserve supplies, and all stocks, whether in Government or private hands, would become subject to allocation on the basis of requirements of national defence. It therefore should be apparent, said Mr. Harriman, that the bidding up of prices would neither increase the total supply of tin in the country, nor the amount available to particular consumers, no matter what they paid for it.

It is reported from Singapore that the Straits-New York Conference has notified shippers that Conference vessels, though short of space, have ample deadweight tonnage available and are, therefore, able to accept any tin which may be offering. In certain circumstances, it is not permissible to ship tin in non-Conference vessels. It will be recalled that last month it was announced that shippers to ports on the Atlantic coast of North America were permitted to ship without penalty by non-Conference tonnage which might be available during March.

Tin prices on the London Metal Exchange during the past week have been as follow:—

Cash—Thursday, £269 to £270; Friday, £269 5s. to £269 15s.; Monday, £272 to £272 5s.; Tuesday, £271 5s. to £271 10s.; Wednesday, £272 to £272 5s.

Three Months—Thursday, £267 to £267 5s.; Friday, £267 10s. to £267 15s.; Monday, £269 15s. to £270; Tuesday, £269 to £269 10s.; Wednesday, £270 15s. to £271.

Spelter—Brassmakers, galvanisers and die-casters have a considerable volume of Government work on hand, and are taking up large tonnages of spelter; supplies are sufficient to meet all priority demands, but for other purposes close scrutiny is made of all applications for purchasing licences.

A proposal to form a zinc pool is reported from the United States; producers will contribute 5 per cent. of their output for the satisfaction of Government defence requirements. According to the American Zinc Institute, zinc production in February (a short month) totalled 55,414 short tons, against 59,156 tons in January. Deliveries were also lower at 59,220 tons, compared with 63,272 tons. Stocks at the end of February were only 4,962 tons, which is equivalent to about three days' supply at the present rate of demand, which is at a high level. Zinc is subject to licensing regulations for export, and permits are, generally speaking, granted only to British Empire and Latin-American buyers, so that the export trade is quiet.

Lead—Ordinary industrial demand for this metal has fallen away appreciably since the outbreak of hostilities, so that priority users are now able to secure all they require promptly, while supplies are available also to non-essential buyers quite freely. The Control is maintaining a watchful eye over the position, however, in order that shipments may be regulated to cope with the demand.